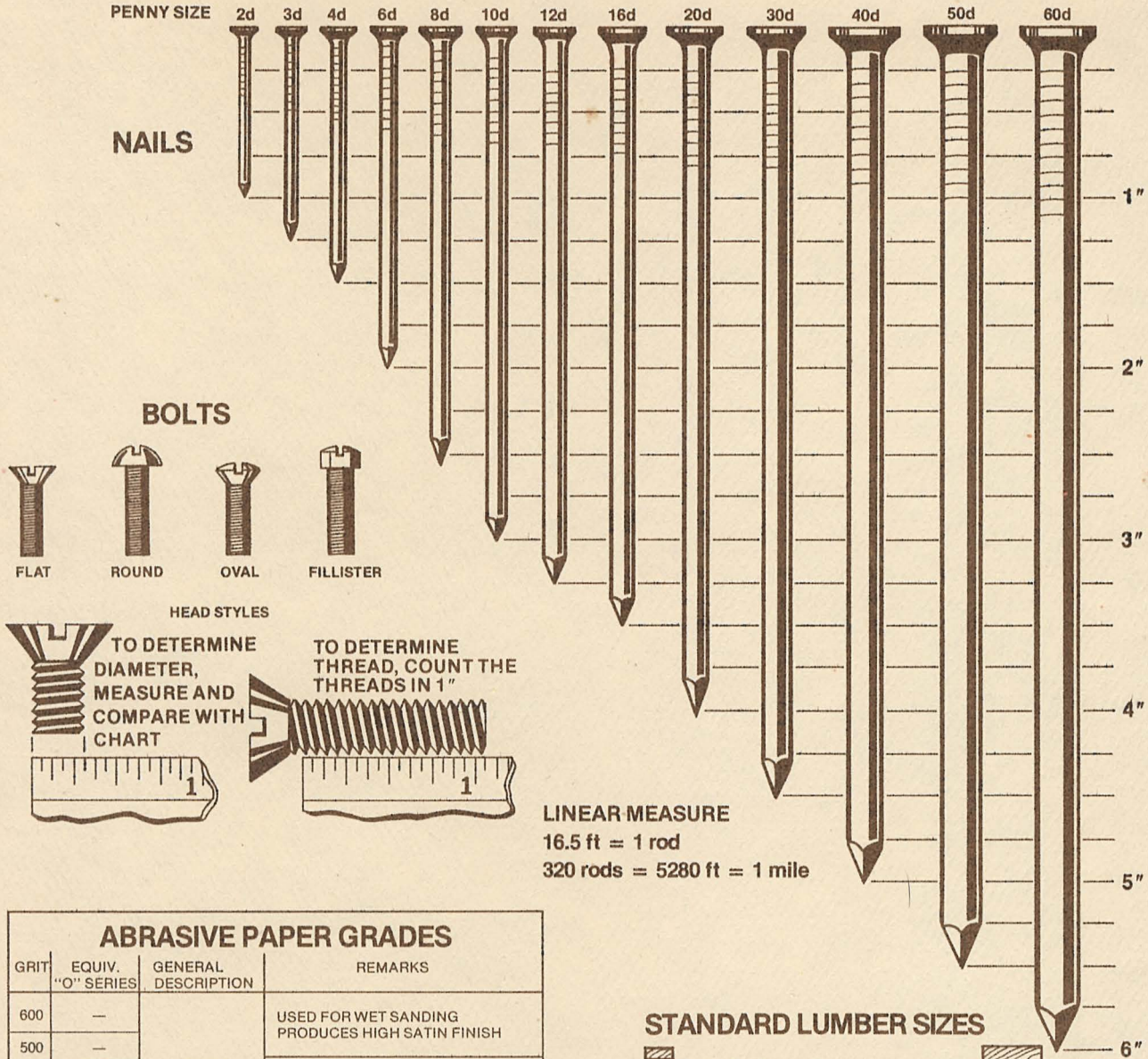
Popular Mechanics

do-it-yourself encyclopedia

SHOP GUIDE



BOLTS

HEAD STYLES

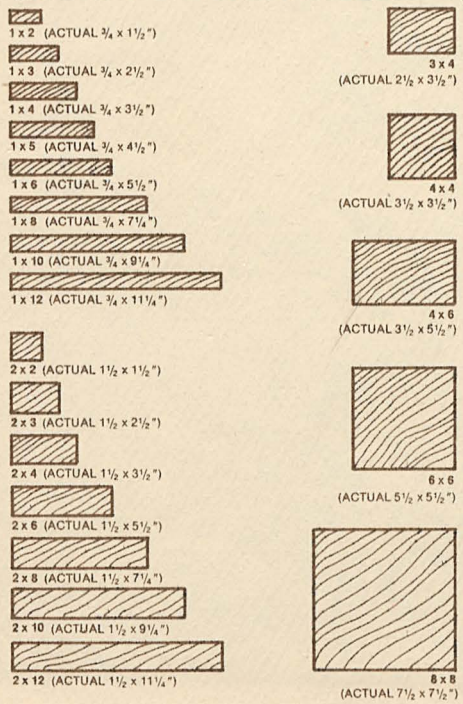
LINEAR MEASURE
16.5 ft = 1 rod
320 rods = 5280 ft = 1 mile

ABRASIVE PAPER GRADES

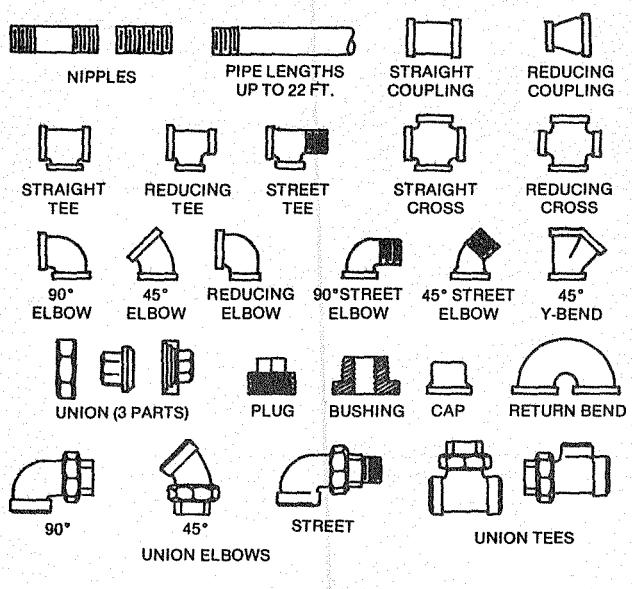
GRIT	EQUIV. "O" SERIES	GENERAL DESCRIPTION	REMARKS
600	—	SUPER-FINE	USED FOR WET SANDING PRODUCES HIGH SATIN FINISH
500	—		
400	10/0		GENERAL RANGE OF ABRASIVE PAPERS USED FOR WET SANDING LACQUER AND VARNISH TOP COATS
360	—		
320	9/0		
280	8/0	VERY FINE	USED FOR DRY SANDING ALL FINISHING UNDERCOATS. THESE GRADES WILL NOT SHOW SANDING MARKS
240	7/0		
220	6/0*		
180	5/0	FINE	
150	4/0*		FOR FINAL SANDING OF BARE WOOD. GOOD FOR SMOOTHING OLD PAINT
120	3/0	MEDIUM	
100	2/0*		USE FOR GENERAL WOOD SANDING. GOOD FOR FIRST SMOOTHING OF OLD PAINT, PLASTER PATCHES
80	1/0		
60	1/2*	COARSE	USE No. 1/2 FOR ROUGH-WOOD SANDING. No. 1 IS COARSEST PAPER WHICH CAN BE USED TO ADVANTAGE WITH PAD SANDER
50	1		
40	1 1/2		
36	2	VERY COARSE	ALL TOO COARSE FOR PAD SANDERS. THESE GRADES REQUIRE HEAVY MACHINES AND HIGH SPEED TO CUT WELL
30	2 1/2		
24	3		

Grades generally supplied as Very Fine, Fine, Medium and Coarse

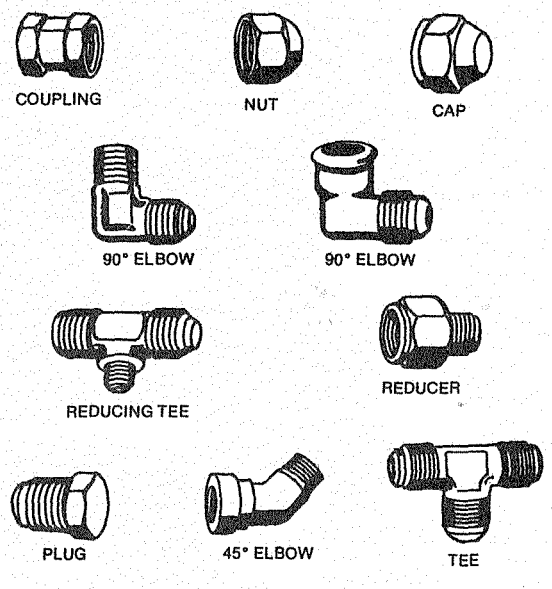
STANDARD LUMBER SIZES


1 x 2 (ACTUAL 3/4 x 1 1/2")
1 x 3 (ACTUAL 3/4 x 2 1/2")
1 x 4 (ACTUAL 3/4 x 3 1/2")
1 x 5 (ACTUAL 3/4 x 4 1/2")
1 x 6 (ACTUAL 3/4 x 5 1/2")
1 x 8 (ACTUAL 3/4 x 7 1/4")
1 x 10 (ACTUAL 3/4 x 9 1/4")
1 x 12 (ACTUAL 3/4 x 11 1/4")
2 x 2 (ACTUAL 1 1/2 x 1 1/2")
2 x 3 (ACTUAL 1 1/2 x 2 1/2")
2 x 4 (ACTUAL 1 1/2 x 3 1/2")
2 x 6 (ACTUAL 1 1/2 x 5 1/2")
2 x 8 (ACTUAL 1 1/2 x 7 1/4")
2 x 10 (ACTUAL 1 1/2 x 9 1/4")
2 x 12 (ACTUAL 1 1/2 x 11 1/4")
3 x 4 (ACTUAL 2 1/2 x 3 1/2")
4 x 4 (ACTUAL 3 1/2 x 3 1/2")
4 x 6 (ACTUAL 3 1/2 x 5 1/2")
6 x 6 (ACTUAL 5 1/2 x 5 1/2")
8 x 8 (ACTUAL 7 1/2 x 7 1/2")

PIPE FITTINGS



Here are the common steel pipe fittings. Nipples are simply short lengths of pipe threaded on both ends. Reducing fittings join two different sizes of pipe.



Compression fittings of the flared-tube type are the easiest for the novice to handle when working with copper tubing.

STANDARD STEEL PIPE
(All Dimensions in Inches)

Nominal Size	Outside Diameter	Inside Diameter	Nominal Size	Outside Diameter	Inside Diameter
⅛	0.405	0.269	1	1.315	1.049
¼	0.540	0.364	1¼	1.660	1.380
⅜	0.675	0.493	1½	1.900	1.610
½	0.840	0.622	2	2.375	2.067
¾	1.050	0.824	2½	2.875	2.469

SQUARE MEASURE

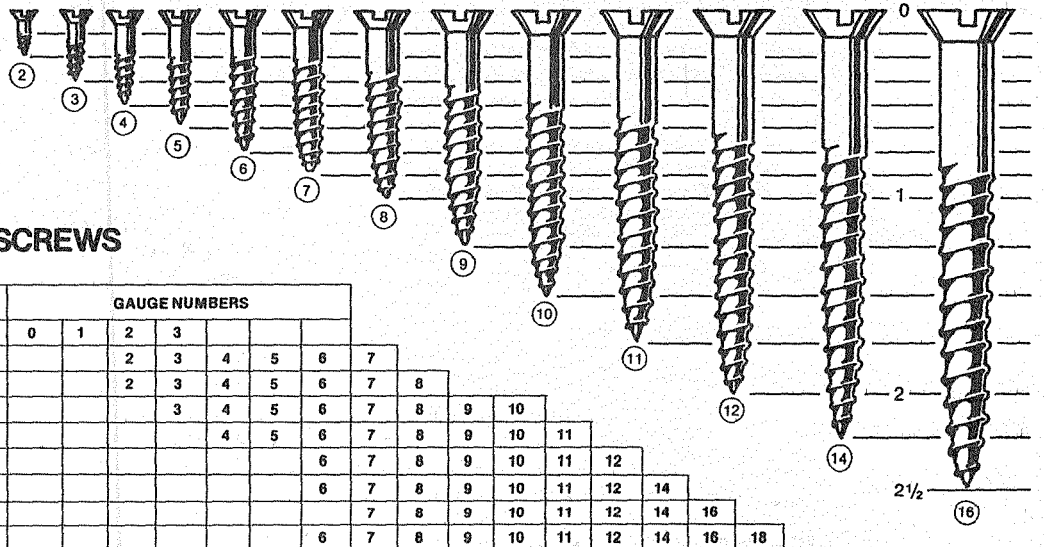
144 sq in = 1 sq ft
9 sq ft = 1 sq yd
272.25 sq ft = 1 sq rod
160 sq rods = 1 acre

VOLUME MEASURE

1728 cu in = 1 cu ft
27 cu ft = 1 cu yd

MEASURES OF CAPACITY

1 cup = 8 fl oz
2 cups = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon
2 gallons = 1 peck
4 pecks = 1 bushel



WOOD SCREWS

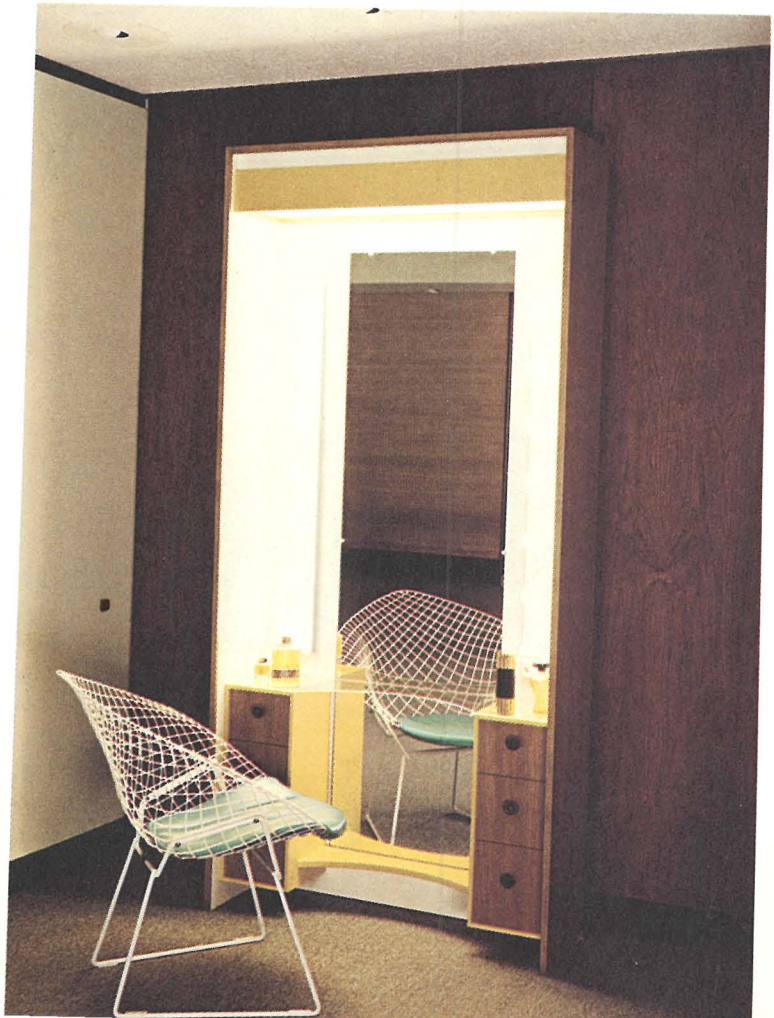
LENGTH	GAUGE NUMBERS																
¼ INCH	0	1	2	3													
⅜ INCH			2	3	4	5	6	7									
½ INCH			2	3	4	5	6	7	8								
⅝ INCH				3	4	5	6	7	8	9	10						
¾ INCH					4	5	6	7	8	9	10	11					
⅞ INCH							6	7	8	9	10	11	12				
1 INCH							6	7	8	9	10	11	12	14			
1¼ INCH								7	8	9	10	11	12	14	16		
1½ INCH							6	7	8	9	10	11	12	14	16	18	
1¾ INCH									8	9	10	11	12	14	16	18	20
2 INCH									8	9	10	11	12	14	16	18	20
2¼ INCH										9	10	11	12	14	16	18	20
2½ INCH													12	14	16	18	20
2¾ INCH														14	16	18	20
3 INCH															16	18	20
3½ INCH																18	20
4 INCH																18	20

WHEN YOU BUY SCREWS, SPECIFY (1) LENGTH, (2) GAUGE NUMBER, (3) TYPE OF HEAD—FLAT, ROUND, OR OVAL, (4) MATERIAL—STEEL, BRASS, BRONZE, ETC., (5) FINISH—BRIGHT, STEEL BLUED, CADMIUM, NICKEL, OR CHROMIUM PLATED.

INEXPENSIVE and readily available at your local lumberyard, standard moldings let you "sculpture" your walls. For especially attractive designs, see page 2064.

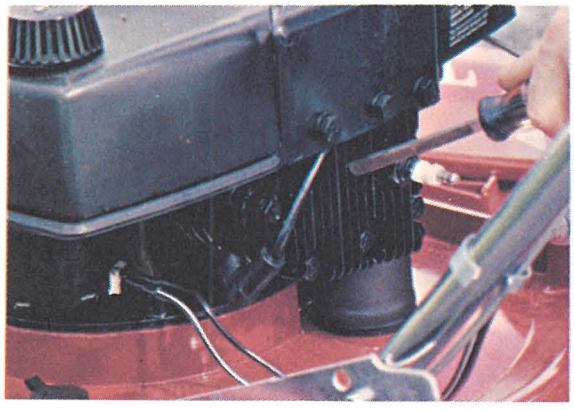
In this volume . . .

WOULD YOU BELIEVE (without looking twice) that the same basic piece of furniture is the focus of all four rooms shown on these pages? Actually, it's a modular frame that you can adapt to many different uses. We show it as a service bar (above); a desk (above right); a personal grooming center (right); and a compact sewing center (far right). In the article on page 2050 you'll also see it as a handsome room divider. We'll bet you'll find other uses for the modular frame, too. And it's easy to build!



FOR A DRAMATIC CHANGE, simply add wood moldings to your walls. Use wallpaper or fabric inside the molding to create a new mood. For ideas, see page 2064.

WANT TO KNOW how to keep your power mower purring? Most mid-season problems are traceable to the wrong amount of fuel in the cylinder, or a faulty spark. See page 2094.



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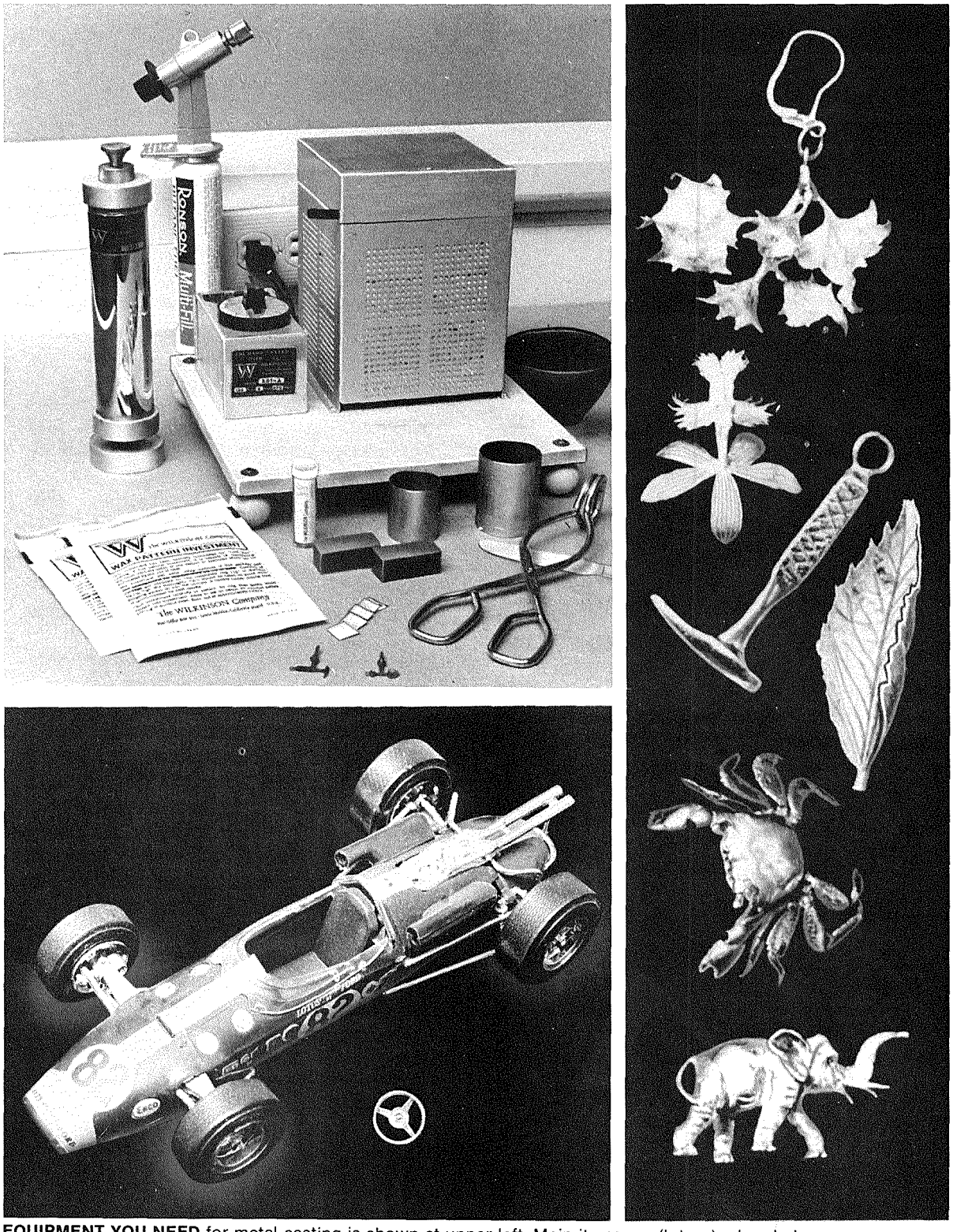


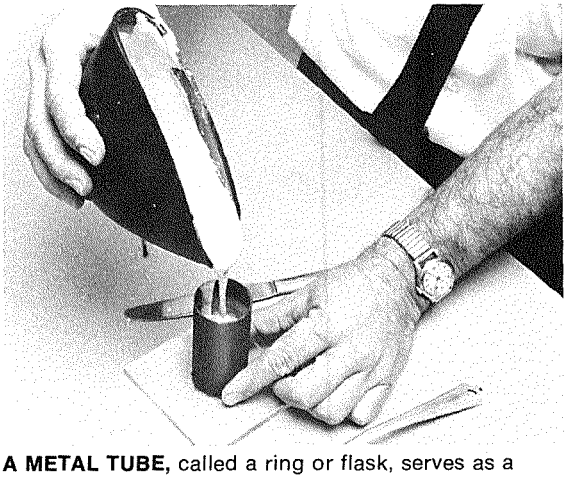
EQUIPMENT YOU NEED for metal casting is shown at upper left. Main items are (l. to r.) a hand air pump, propane torch and electric burnout oven. Other supplies are powdered mold mix (in packets), metal tubes to hold the mold, blocks of carving wax, tongs, small metal ingots, wax sprues and a mixing dish, preferably a flexible rubber or plastic. Tiny steering wheel for the model racing car at lower left and charms and trinkets at right are examples of the many intricate shapes you can cast by lost-wax method.

Make your own metal castings

By C. W. WESTRICK

Like to make special parts for models? A shiny piece of jewelry? The ancient art of "lost wax" casting combined with modern equipment make it easy to turn out just about any metal shape

POWDERED MOLD material is poured into a small dish and then mixed with water to a creamy paste. Stir it gently to avoid whipping up air bubbles in the mix.



A METAL TUBE, called a ring or flask, serves as a container for the soupy mold mix. Fill it flush to the top. You can use a flexible dish to make pouring easy.

SPRAY THE PATTERN—in this case a small leaf—with a wetting agent before embedding it. This lets the mold mix flow smoothly over the entire surface.

■ THERE'S A BIG thrill in seeing a design you have created yourself turn almost magically into gleaming metal. But maybe you figure this requires special know-how and a lot of fancy equipment.

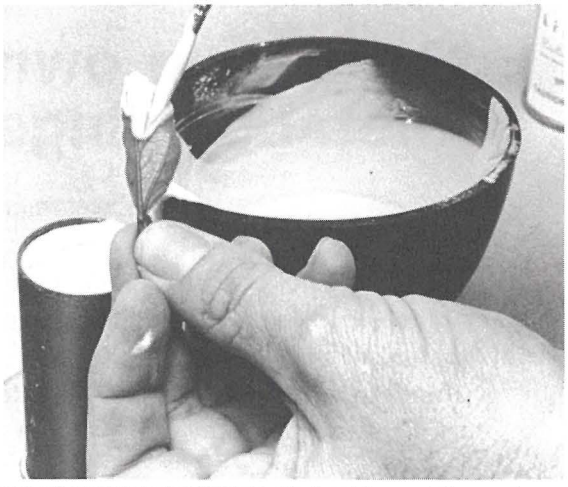
Not today. Hobby shops and lapidary supply houses stock everything you need to cast small model parts or pieces of jewelry in glittering gold, silver and other metals. The process, known as investment or "lost wax" casting, is the same as that used centuries ago by early Egyptians. You carve the shape you want in soft wax, embed the wax in a plaster-like material that hardens around it, then bake it in an oven. Under high heat, the wax vaporizes—is literally "lost"—leaving an empty mold. Molten metal forced into the mold then produces an exact copy of the original wax pattern.

You can make your own wax patterns using a special carving wax, or you can buy patterns ready to use. The latter come in a wide variety of ornaments, charms and small pieces of jewelry. You can also copy actual specimens, such as leaves and insects—anything that will vaporize at 1200° F., leaving little ash.

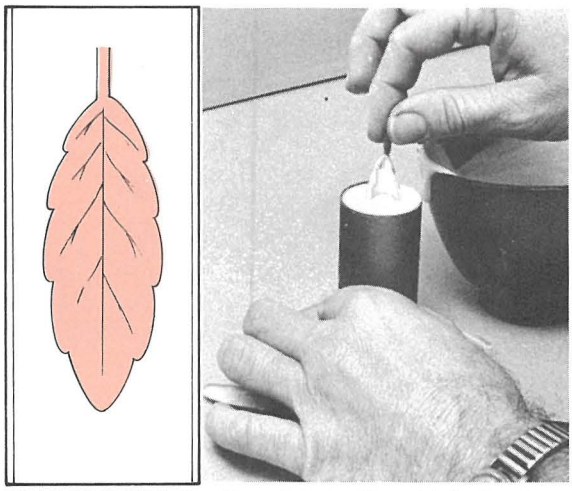
The equipment you'll need includes a small electric oven for burning out the wax, a propane hand torch for melting the metal, an air pump for forcing the molten metal into the mold, and a supply of metal tubes, called rings or flasks, in which the molds are formed. The rings come in a variety of diameters depending on the size of the pattern you want to copy. The mold material, called the "investment," is a white powder that's mixed with water to form a creamy paste.

SEE ALSO

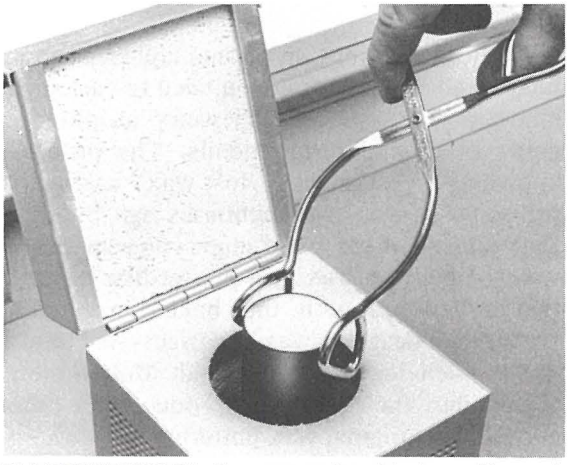
Internal carving . . . Jewelry . . . Lapidary . . . Modelmaking . . . Plaster casting . . . Torches



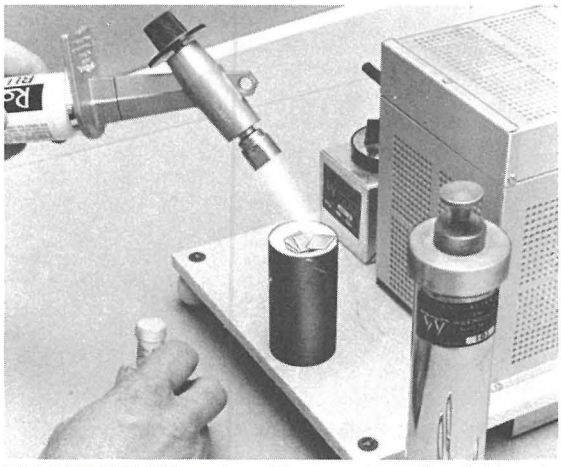
ON INTRICATE OBJECTS, it's best to coat the surface with the mold mix first, using a brush. This insures that the mix will get into all the crevices.



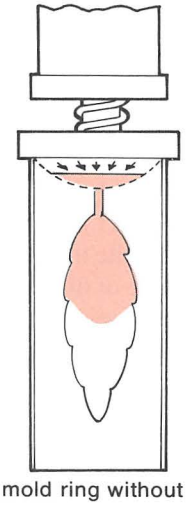
THE PRECOATED pattern is now dipped into the ring containing mold mix. Be sure it is submerged and fully surrounded by the mix with no air pockets.



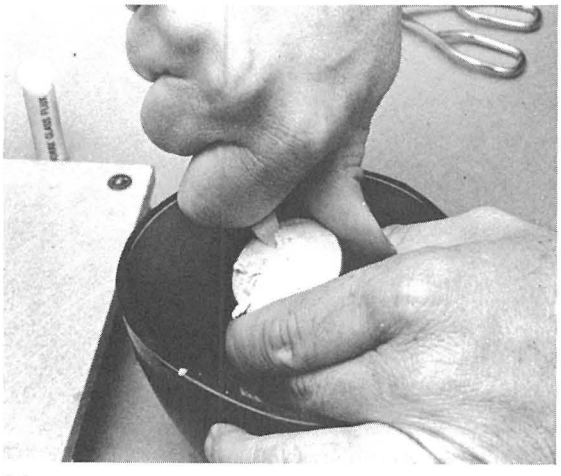
PLACE THE MOLD in the oven crater-side down. Burnout takes from 30 to 60 minutes for wax patterns. Less combustible materials may need several hours.



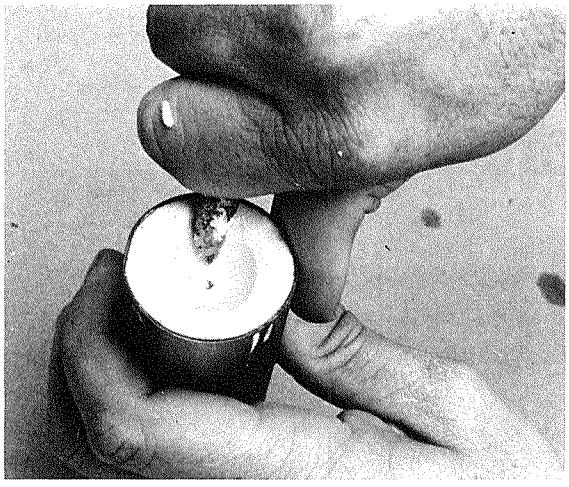
FILL THE MOLD'S crater with several small metal ingots after the burnout. Play the torch flame over them until a ball of molten metal is formed.



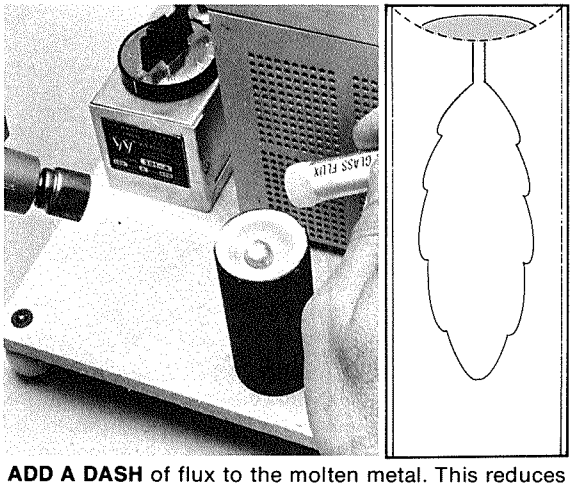
PRESS THE PUMP down over the mold ring without removing the torch. The pump's pressure forces the molten metal down in the mold, as the sketch shows.



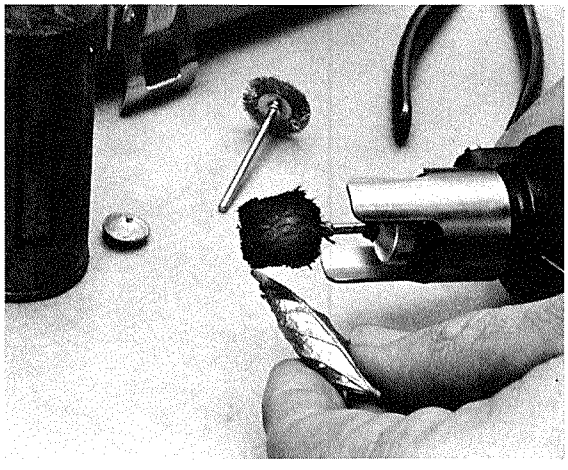
SOAKING THE MOLD in water loosens it and allows it to be peeled away from the casting. The remaining bits can easily be taken off with a toothbrush.



LET THE MOLD harden for 45 minutes or so, then scoop out a shallow crater on top to hold the metal. Be sure that this exposes the sprue on the pattern.



ADD A DASH of flux to the molten metal. This reduces oxides that produce a crust. The sketch shows how the metal forms a puddle above the empty mold.



FINISHED CASTING can be polished to a sparkle with a small buffing wheel like the one shown. Use tripoli or jeweler's rouge for best results.

Altogether, everything you need for investment casting can be had for around $100.

In some areas, it may be possible to rent the burnout oven and casting pump.

One large supplier of casting equipment and materials is the Wilkinson Co., P.O. Box 303, Santa Monica, CA.

It's important to use clean metal as dirt particles can result in an imperfectly formed casting. It's also important not to trap air bubbles around the wax pattern when embedding it in the mold. Tiny bubbles leave pockmarks in the mold.

The accompanying photos show the procedure for making a typical casting. Before the pattern is embedded in the investment material, it's necessary to add a small stem, called a "sprue," so it sticks up through the mold to the top. When the sprue, usually made of wax, melts away, it leaves a tiny hole in the mold. This enables you to get molten metal down into the mold cavity from the outside.

"casting" the metal

Note that the molten metal will not just flow down the sprue hole by itself—surface tension prevents it. You must actually force the metal into the mold under pressure, and this is what's known as "casting." The usual casting device is a small hand-operated air pump. Pressure is first built up in the pump by giving the plunger about 15 strokes. Then the pump is placed over the investment ring and pressed down. This releases the air, driving the molten metal into the mold.

Hold the pump over the mold 30 seconds until the metal has become completely solidified or "frozen." To remove your casting from the mold, place the mold in a bowl of water. Allow it to stay there until the water has completely soaked into the material. This should cause the mold to break away easily from the casting. Breaking renders the mold unusable a second time.

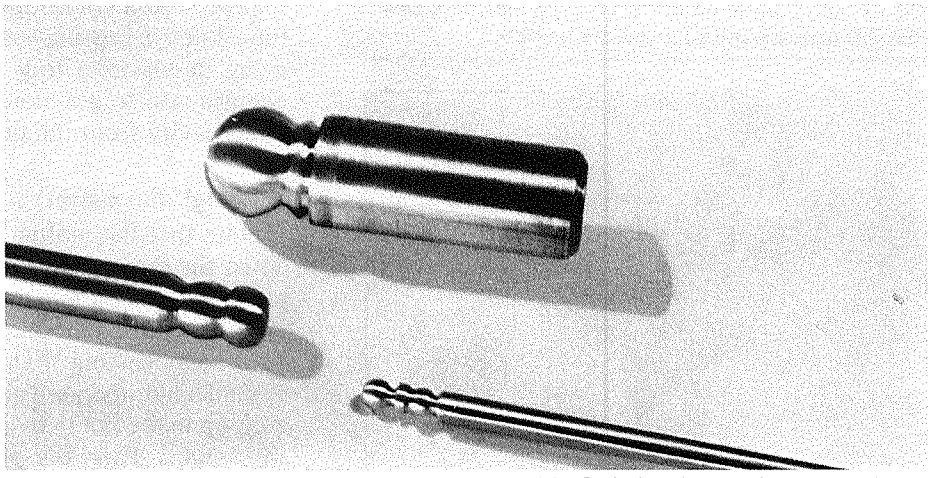
It's quite likely that the casting will appear discolored. This discoloration is a surface oxide and is easily removed by pickling the casting in an acid solution—two parts muriatic acid to one part water is usual.

After pickling, remove the sprue stem from the casting with a pair of wire-cutting pliers. Then grind or file off the remaining stub. The best method of polishing your casting is with some type of rotating polisher. The most common compounds used for final finishing are tripoli and jeweler's rouge, applied with a soft buffing wheel.

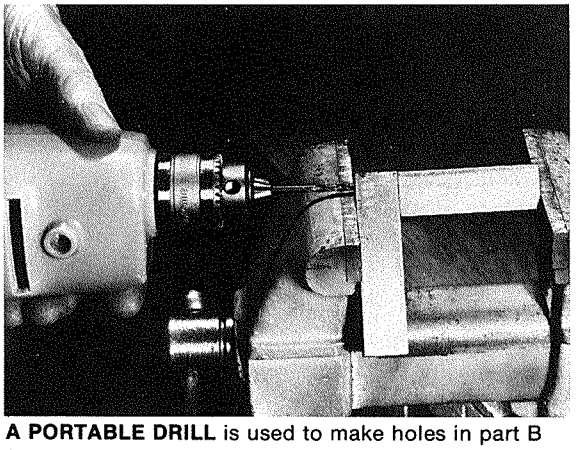
Lathe ball-turning attachment

You'll be able to machine a reasonably perfect ball-shaped knob or neat convex segment on a decorative spindle with this lathe ball-turning attachment. Its uses are limited only by your imagination. Here's how you can make and use one

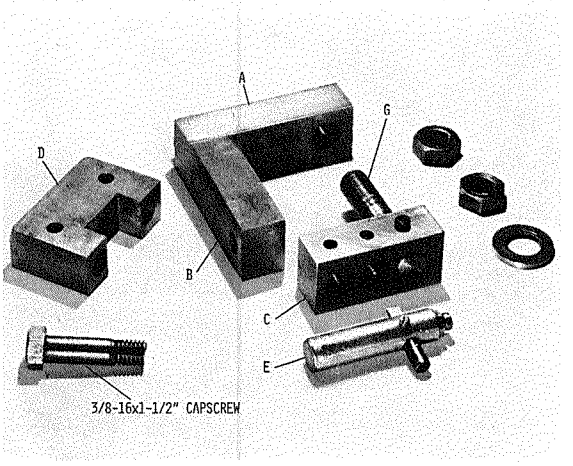
By WALTER E. BURTON



SEVERAL EXAMPLES of what the attachment can do are shown above. Diameters here are ¼, ½ and 1 in. Variations need be limited only by your imagination.



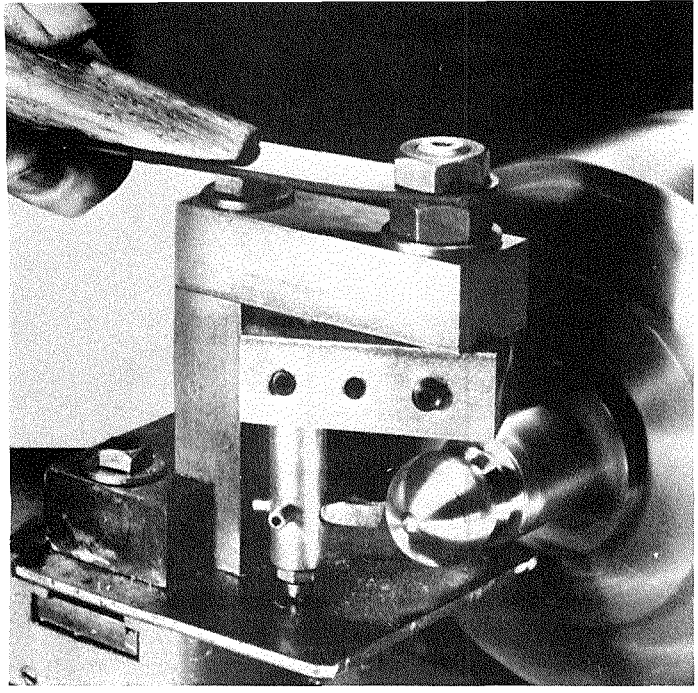
A PORTABLE DRILL is used to make holes in part B (see page 1930) for the two ⅛-in.-dia. pins which help to align part A with the upper end of B.



PARTIAL ASSEMBLY: A and B are joined and block C is attached to pivot G. Cutter-post assembly E uses a section of ¼-in. rod as the cutter.

SEE ALSO

Drill-press techniques . . . Drills, portable . . . Machining . . . Metal-lathe techniques . . . Tools, hand



A BALL-SHAPED KNOB is machined (above) with the ball-turning attachment mounted on a 9-in. lathe.

■ MANY KINDS of ball-turning gadgets have been devised for lathes. I designed this bit for machining ball-shaped knobs and pulls, for forming rounded ridges and edges and for making convex segments on decorative spindles and handles. It works like a charm.

To be able to accomplish these turnings, you need a cutter that can be pivoted properly around a fixed center. The attachment shown, designed to do just that, consists essentially of a steel-bar frame supporting a lever-controlled swinging arm. Extending down from the arm is a rod in which the cutter is mounted.

Possibly this arrangement would work consistently without a support for the lower end of the cutter rod, but this end was provided with an adjustable screw whose head slides over a steel plate. The downward cutting force against the cutter is thus counteracted partially by the plate, lessening stress on the supporting frame and reducing the tendency to chatter.

The model, made from available shop stock, was dimensioned to fit a 9-in. lathe to machine balls ranging in diameter up to about 1½ in. Set up as shown, the attachment normally shapes most of a ball but leaves it attached to a stem. By carefully adjusting the cutter until its tip can cut to the center without the holder or other part striking the work, you can machine a ball completely, or until it breaks off.

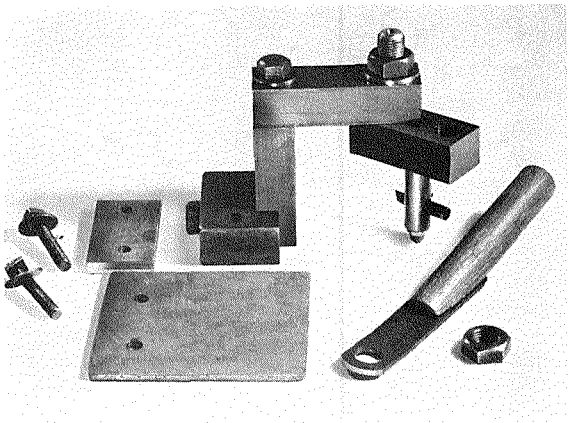
The attachment is clamped to the compound slide of the lathe, in place of the usual toolpost assembly, by two bolts engaging a bar (J in drawing, page 1930) in the T-slot. It could be manipulated to make concave cuts within a limited radius range. Even a greater range might be machined with a simpler setup described later.

Parts used in the model attachment include four steel blocks, a steel plate, and miscellaneous bolts and screws. Much of the frame, represented by pieces marked A, B and C, was made from ¾ x 1-in. steel bar. The base block (D) is wider in order to span the T-slot in the compound slide. A steel plate (F), ⅛ in. thick, was interposed between D and the compound to serve as a platform over which the cutter-holding rod slides. Strip J was made to fit the toolpost slot of the lathe.

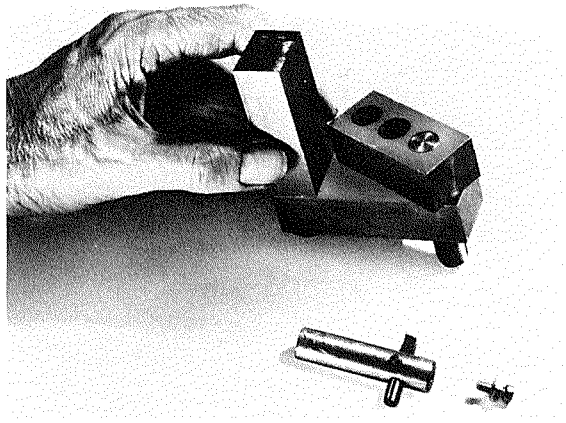
making the shaft

The ½-in. shaft (G), which serves as the pivot for the swinging movement of the tool, was a piece of ½-20 bolt whose diameter happened to be reasonably accurate. It could have been made from drill rod or shafting threaded at one end. The cutter holder (E) was made from the same

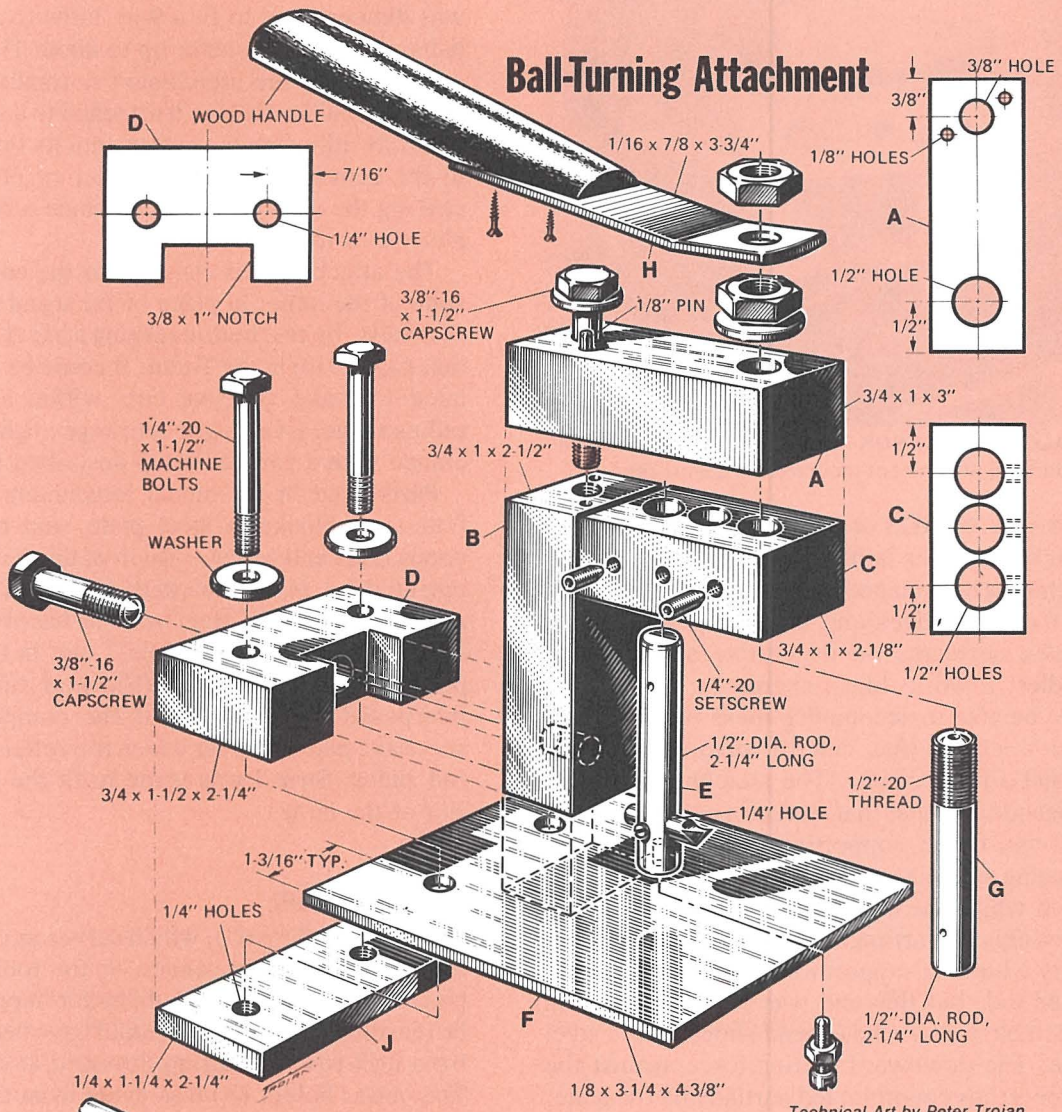
THE BALL-TURNER DISASSEMBLED. To fasten each of the joints, bolts and pins were used in the attachment.



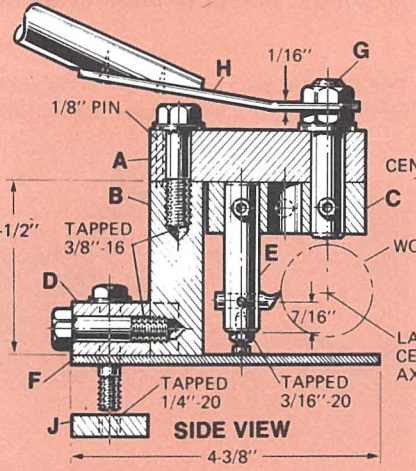
THE BLOCK, seen from below, shows how the swinging block pivots so it just misses the upright on the frame.

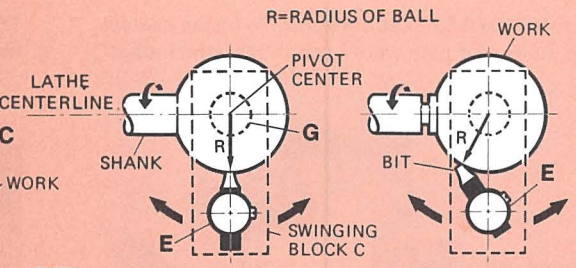


Ball-Turning Attachment



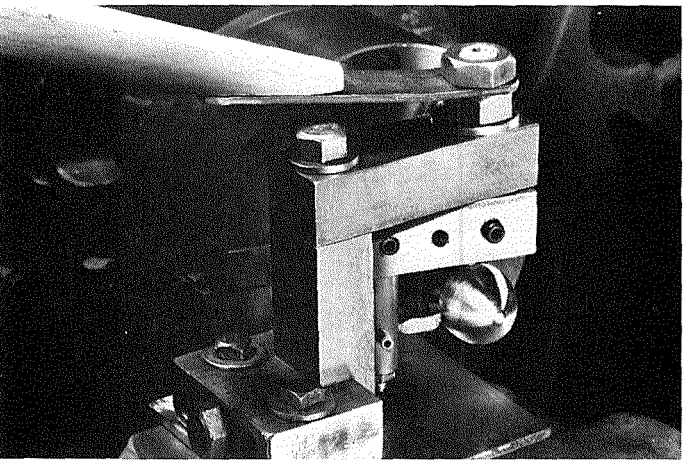
Technical Art by Peter Trojan



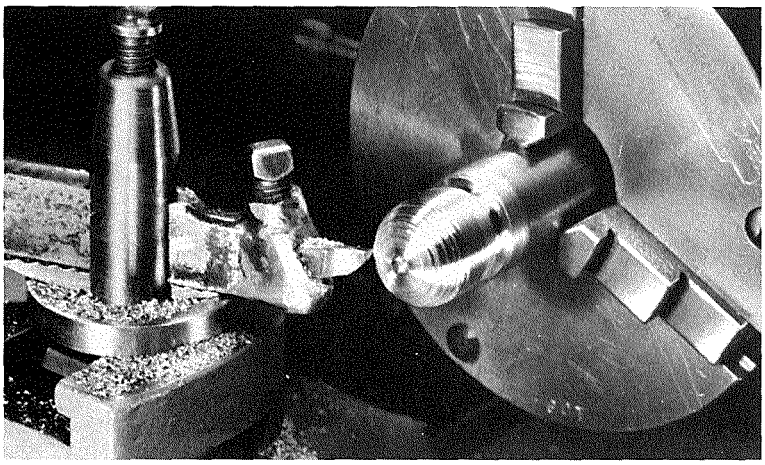


WHEN BIT is swung to one side by rotating E, tip cuts closer to the centerline. The bit cuts on both the side and tip.

NORMAL SETUP has bit-point approximately in plane of bolt G and rod E. Finished ball has stem (as for a drawer pull).



TWO ¼-IN. BOLTS hold the attachment in position over the toolpost slot of the lathe carriage.



THE 1-IN. BALL is first roughed out with conventional tooling to save wear and tear on the ball turner.

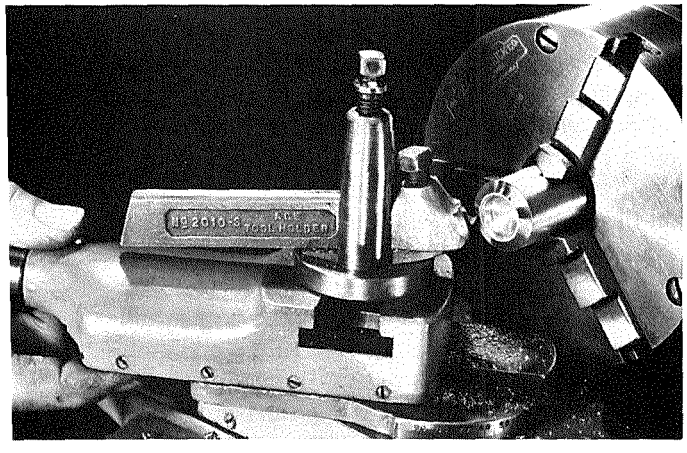
bolt. For ease of construction, bolts and pins were used to join the sections forming the frame of the model illustrated. The ⅜ and ½-in. holes in A were drilled and reamed to be reasonably perpendicular to the drilled surfaces.

The joint between A and B was assembled by first drilling, in A, a $^5/_{16}$-in. hole where the bolt is to go, then flanking this with two ⅛-in. holes for pins. The two parts were clamped, in alignment, in a vise, with one pinhole exposed. Each pinhole was made in B with a portable drill—the first pin being installed to help align the parts for drilling the second pinhole. The second pin was added to help hold the parts in alignment while the $^5/_{16}$-in. hole was continued into B. Then the $^5/_{16}$-in. hole in A was enlarged for a ⅜-16 bolt, and that in B tapped for the bolt thread. Of course, the end of part B had to be square to form a right-angle joint.

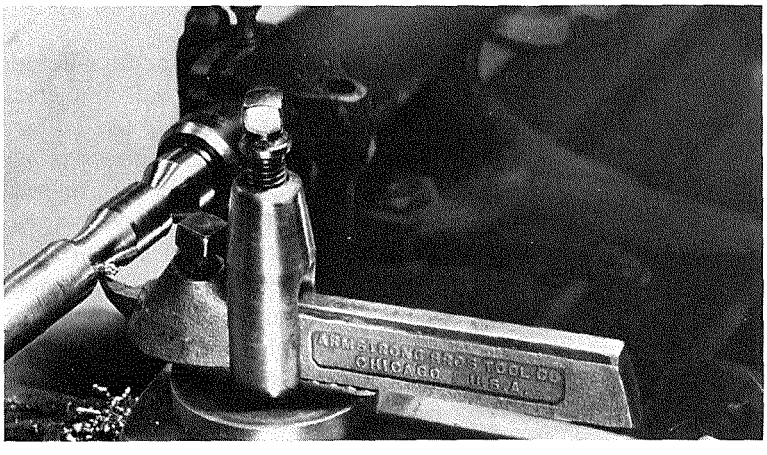
The base block (D) was notched to a depth of ⅜ in. to receive the upright (B). The notch was milled but could have been made by drilling and filing. A ⅜-in. bolt through D engages a threaded hole in B to hold the joint firmly together.

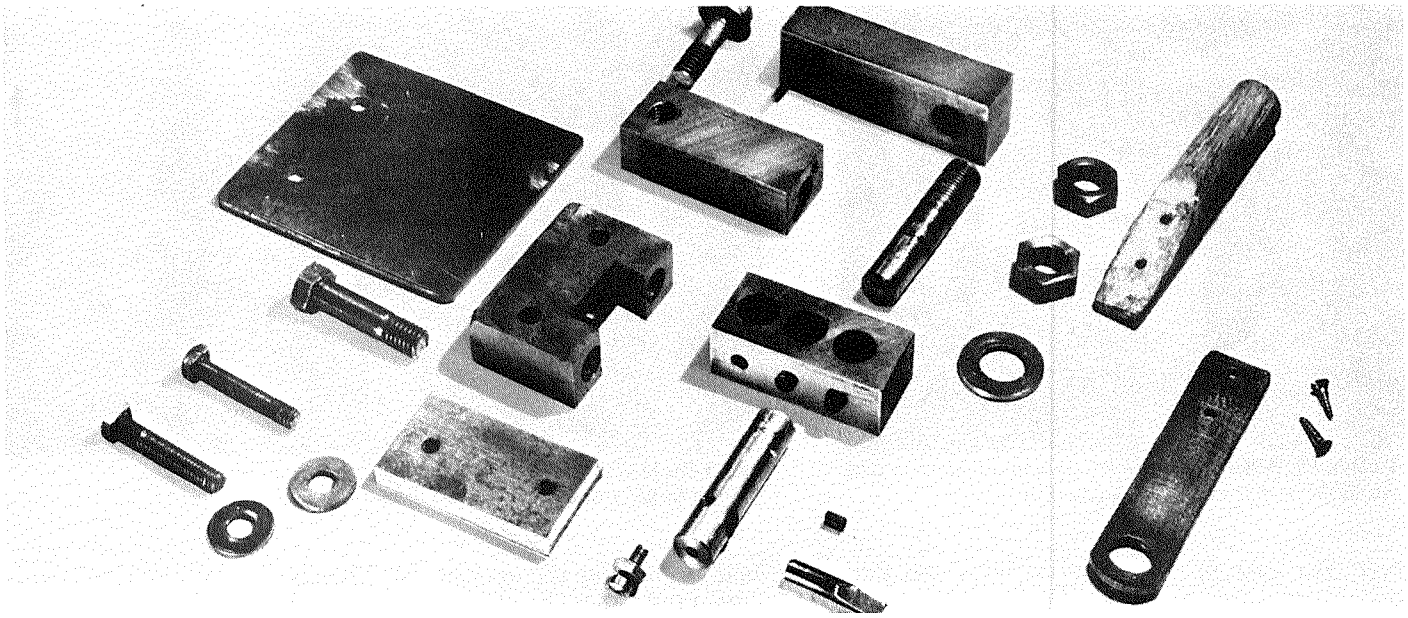
The swinging block (C) has a row of three ½-in. holes, two for the cutter rod and one to attach the block to pivot bolt G. Each hole was provided with a ¼-20 setscrew. A handle is attached to the top of bolt G with two nuts to control swinging; the nuts shown were reduced to about $^5/_{16}$-in. A brass washer between the lower nut and arm A acts as sort of a bearing. The handle was made by drilling a ½-in. hole near one end of a $^1/_{16}$ x ⅞ x 3¾-in. steel strip and attaching a ¾ x 4-in. wooden handle. The handle can be shaped from a block of wood or cut from a broomstick or dowel. Or, if you have the equipment, you can turn the handle to shape on a wood lathe. The wooden portion is fastened to piece H with two wood screws.

TO GENERATE a concave chamfer on a 1-in. brass rod, the swinging compound slide is brought into play.



CONCAVE CUTS can be made without the attachment, using a bit mounted in the holder and compound swing.





PARTS FOR THE MODEL SHOWN were shaped from available stock in the author's shop.

installing the cutter-holding rod

The cutter-holding rod (E) is approximately 2¼-in. long in the model. Its lower end has a $^3/_{16}$-20 bolt and locknut positioned as shown. Its upper end is clamped in block C with a setscrew. The hole for the cutter was not drilled until the attachment had been assembled on the lathe. Then it was easy to mark the position of the cutter with respect to the lathe axis—using a scriber point in a tailstock chuck. The hole is placed so the cutting tip of the cutter normally is aligned with the axis.

The attachment shown uses ¼-in.-dia. high-speed steel bits, so a round hole was made in E. If square cutter bits had been used, the hole could, of course, have been filed square. The bit setscrew on the model is 8-32.

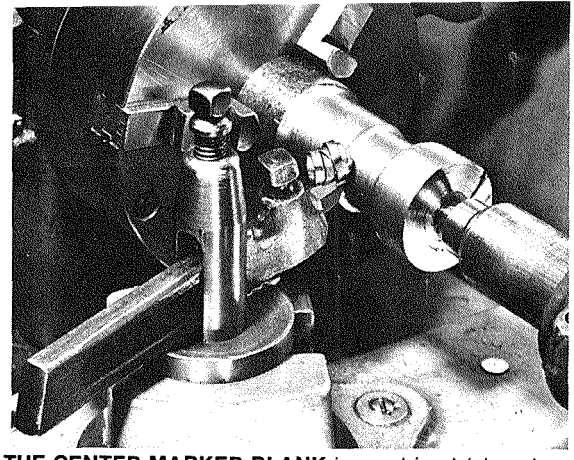
Two positions were provided for cutter-holder E in block C, so that a range of ball diameters could be covered without having to use cutters with very long overhang. Ball diameter is adjusted by positioning the cutter tip with respect to the centerline of bolt G. It would help to provide a tiny hole on the lower end of G to indicate its center—from which measurement could be made. Two adjustments control cutter position: selecting the hole in block C and sliding the cutter in its hole. Care is taken that the tip of the cutter is not swung out of alignment; it usually should be in the same plane as the centerlines of bolt G and cutter-rod E. The cutter shown was ground with a fairly narrow point, a modest side rake and *some* back rake. It seemed to work very well on brass and steel. Because of the side rake, it cut more freely in one direction of swing than the other.

leave in some vertical play

It seems desirable to have a little vertical play in bolt G. Platform F was not perfectly flat and play permitted the bolt at the bottom of cutter rod E to ride freely throughout its swing—aided by a film of oil under it. Under the cutting pressure against the cutter, everything in the prototype became rigid enough to produce nonchattering cuts.

To make concave cuts, arm C could be swung 180° to project outward beyond the axis of G and the cutter reversed in its hole. If this were comtemplated, platform plate F should be extended far enough to support the cutter rod in its outermost position.

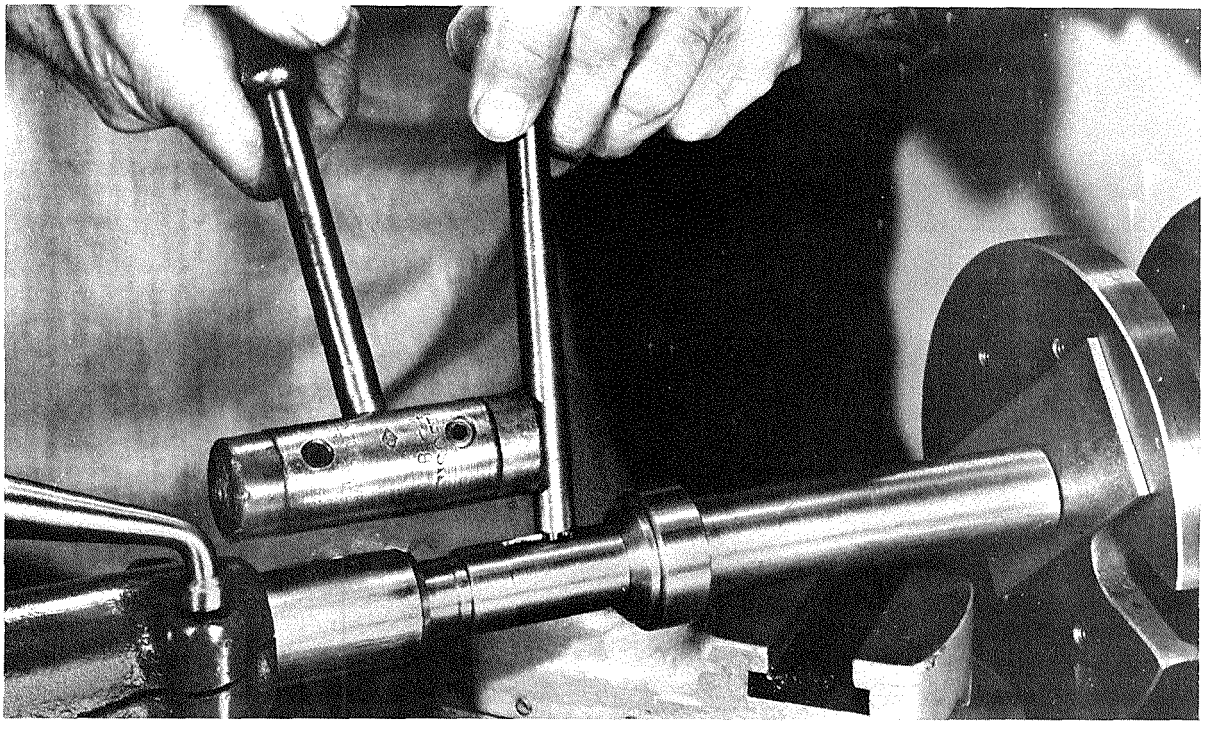
However, there is a way to make concave cuts on the average lathe without attachments other than the regular toolpost, cutter and holder. This is done by loosening the screws that lock the angle of the compound rest, so the compound can be swung around its pivot center while a cut is being made. The more the distance between toolpoint and center of the swing can be reduced, the shorter the radius of curvature.



THE CENTER MARKER BLANK is machined (above) while supported at the outer end by the tailstock center for greater rigidity. When the marker is used in a lathe (below), the extension bar on the marker-punch "handle" is struck with a mallet.

A center marker for lathe work

Center-marking a bar for machining in a lathe is a simple matter with this handy tool. You make the tool itself on your lathe



■ WITH THIS TOOL it is no trick to locate and punch-mark the center of a bar to be mounted in a lathe for machining. And the tool itself makes an interesting lathe project. The marker is essentially a tailstock cup center with built-in punch operated from the side. If carefully made, it can be accurate and fast.

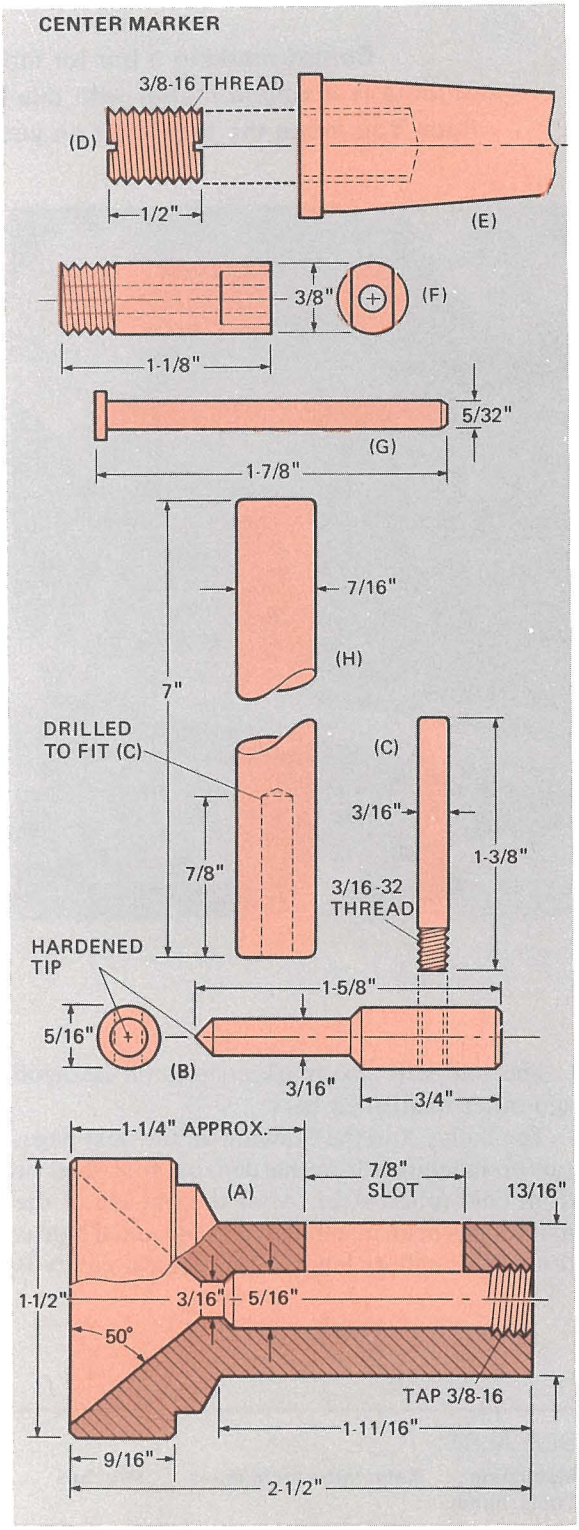
The marker has a conical cup which accepts the end of the bar to be center-punched. The bar end, which is square with the axis and uniform in circumference, centers automatically in the cup. Then the sliding punch is brought forcibly against the bar to make a mark which later can be enlarged, or shifted, if necessary, with a hand punch, prior to center-drilling.

The tool will also mark centers on hexagon and other multisided bars.

The body, A in the drawing on the next page, can be machined from hardenable tool steel or from cold-rolled steel. After the outside of the marker has been machined, a $^{3}/_{16}$-in. axial hole is drilled through its length. The conical cavity is

SEE ALSO
Machining . . . Metal-lathe techniques . . . Punches . . . Tools, hand

center marker, continued



then formed. In the drawing, a 50° angle is indicated. If this is changed, some alterations in punch dimensions might be needed.

Next, cut the body to length and reverse in the chuck to enlarge the axial hole to $^{5}/_{16}$ in., to a depth of about 1-$^{9}/_{16}$ in.—that leaves a portion ($^{3}/_{16}$-in.) of the bore between it and the cup. The outer end of the $^{5}/_{16}$-in. hole is threaded for the ⅜-16 mounting stud D, or sleeve F.

The punch (B) is of hardenable steel such as drill rod. Diameters of the small and large sections are regulated so the punch slides easily but with minimum lost motion in the bore of body A. Handle C projects through a slot in the side of A and is usually the means by which the punch is operated.

Threaded stud D allows coupling body A to taper shank E for mounting the tool in a Morse-taper spindle or drill press. Cross slots are for screwdriver removal of the stud. The taper shank of a broken drill bit can be used for E.

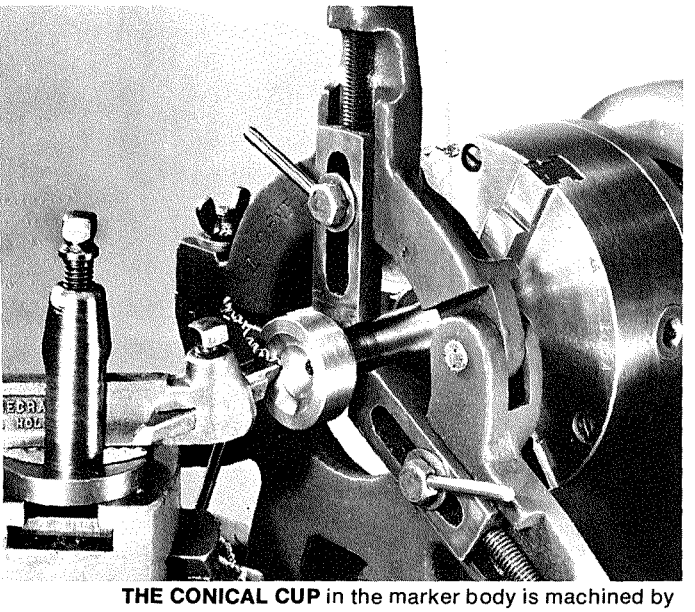
The tool can be used as a hand-held, bell-cup center punch by substituting sleeve F for the tapered shank. This is made from a ⅜-in. bolt, in which sliding pin G (made from a large nail) operates. With plug and pin in place, a light hammer blow on G will mark center. Punch and bar must align.

using the marker in a lathe

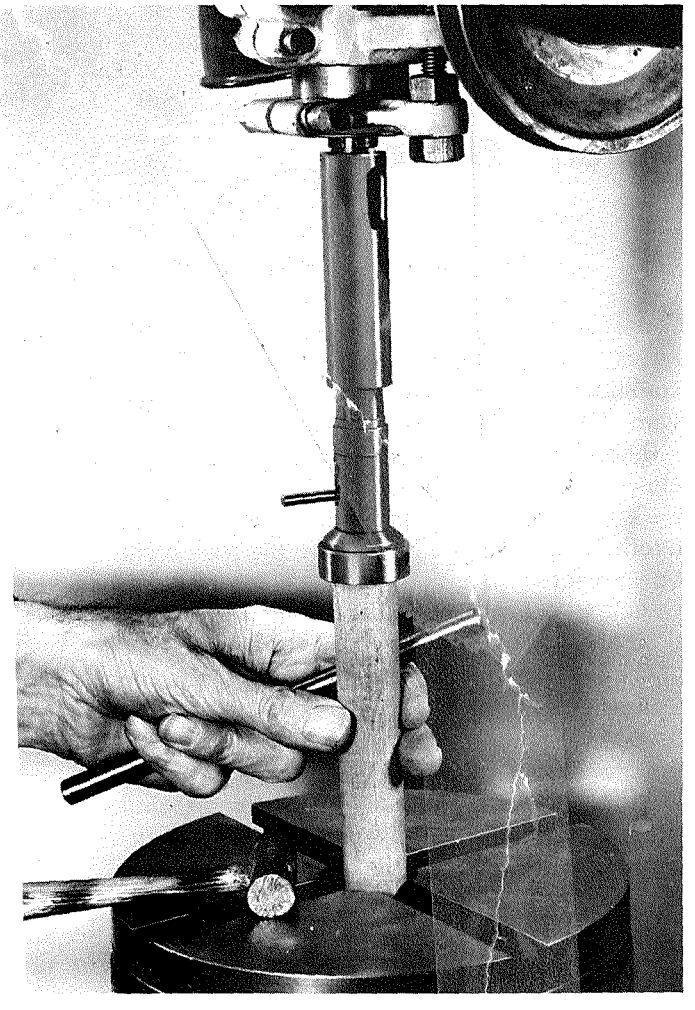
When the center marker is used in a lathe tailstock or drill press, the punch must be operated by means of handle C. You could strike C's side with a hammer, but this might bend it. Bending is less likely if an extension bar (H) is slipped over C, and the outer end of H is held steady while the bar is struck near the marker body.

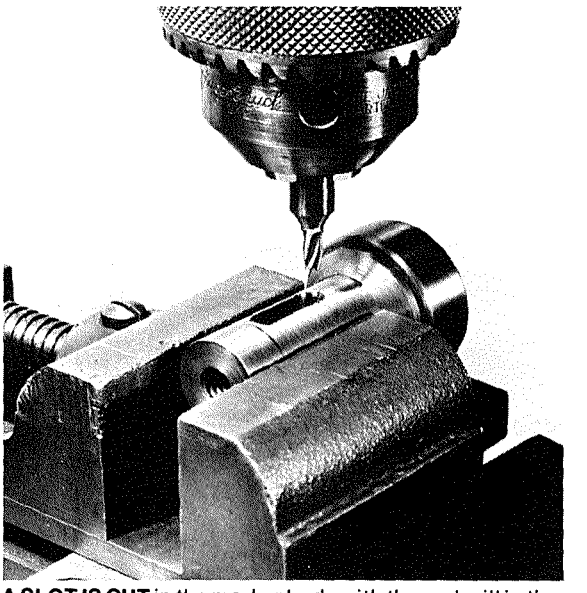
Before marking a bar, its end must be squared and any burrs removed. Support the bar during the center-marking operation, so it will be in alignment with the marker while its end can shift laterally to center itself in the cone cup. Clamping a bar, especially a short, rigid one, in a chuck may cause its outer end to be off center and supported too rigidly to seat in the cup properly. It is better to rest the bar against the end of the headstock spindle (or something covering the spindle, such as the flat plate in the photo at bottom of page 1933), with the tailstock spindle forced against the bar end with enough pressure to hold everything in place while the punch is operated. The same goes for a drill-press setup.

The center marker will handle workpiece diameters from about ¼ in. to nearly the maximum diameter of the conical cup.

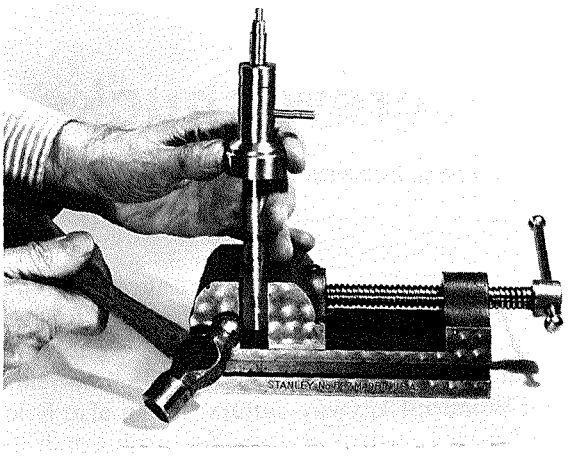


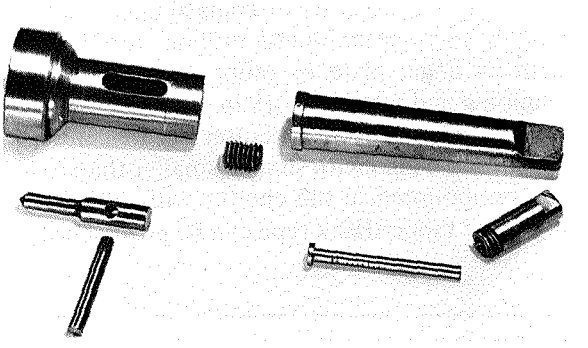
THE CONICAL CUP in the marker body is machined by feeding the tool with the compound slide set to give the cone angle (above). The outer end of the body is steadied by the steadyrest. Below, the tool is being used on a drill press to establish centers on a wooden dowel that will then be lathe-turned.



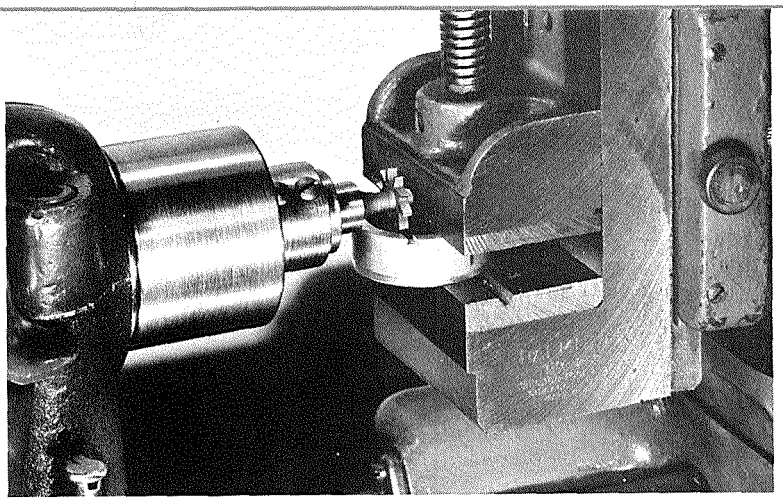


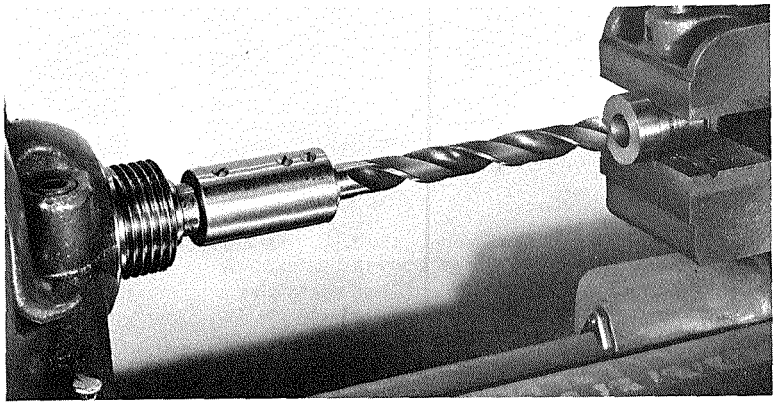
A SLOT IS CUT in the marker body with the end mill in the drill-press chuck (above). A milling-table attachment, not visible in the photo, controls vise movement. Though intended for lathe or drill-press work, the marker can be used as a hand-held, bell-cup center punch as below. A sliding-pin arrangement subs for the tapered shank.





CENTER MARKER PARTS, with the exception of extension arm H, are shown above. The body, A, can be machined from hardenable tool steel or cold-rolled steel.





MOUNTED in screw-on setscrew (top photo), a Woodruff-keyway cutter is used to slot a ring. Work is held in carriage-mounted milling attachment. Taper-shank setscrew chuck (bottom photo) is better suited for drilling and operations in which pressure is lengthwise.

Setscrew chucks you can make

By WALTER E. BURTON

■ A SIMPLE SETSCREW chuck for the headstock spindle of a lathe can be as useful as a costly three-jaw chuck. A setscrew chuck is commonly used for holding drill bits, end mills and Woodruff-keyway cutters. It can also hold workpieces, such as shafting, for turning or drilling. Setscrews bearing against the tool shank lock it in the chuck bore.

Setscrew chucks are often used in connection with a carriage-mounted milling attachment, with an angle plate or other arrangement for clamping and moving work in proper relation to drill bit, reamer, milling cutter, slitting saw, or other tool. Tools with shanks smaller than ½ in. can be mounted in the chucks with split bushings. The taper-shank type can be provided with two or more interchangeable heads having different hole diameters. A setscrew chuck can accommodate a conventional geared drill chuck with a ¼-in. shank projecting an inch or two.

There are two general types of setscrew chucks. As detailed here, chuck A screws over the spindle nose, and is preferable with minimum overhang is desirable and where the tool might be subjected to considerable side pressure. Chuck B has a taper shank fitting the spindle bore and a somewhat greater overhang.

Carefully made and fitted, either type can run as true as the average multijaw chuck or conventional drill chuck fitted with a taper shank.

• **Screw-on setscrew chuck.** This is screwed on the threaded end of the headstock spindle until firmly seated against the spindle shoulder. Cutting its thread is tricky. To fit a 9-in. lathe spindle, the thread is 1½-8 in a 1-in.-deep hole.

A 2-in. round steel blank about 2½ in. long is clamped in a three-jaw chuck, the end faced, and a ½-in. axial hole drilled 1 in. deep. With larger

SEE ALSO
Drill presses . . . Drill-press accessories . . . Metal-lathe techniques . . . Tools, hand . . . Twist drills

drills and a boring bar the hole is enlarged as required by the spindle-nose thread—here to about 1.345 in. dia., slightly larger than the standard 1.3376-in. for this thread. The bore diameter is further enlarged to a generous 1½ in. at both ends. Length of the inner, 1½-in.-diameter bore is determined by the clearance required by the threading tool—about $^3/_{16}$ in. To determine various dimensions of the threaded bore, the spindle nose and back plate of a chuck that fit the nose were used as guides.

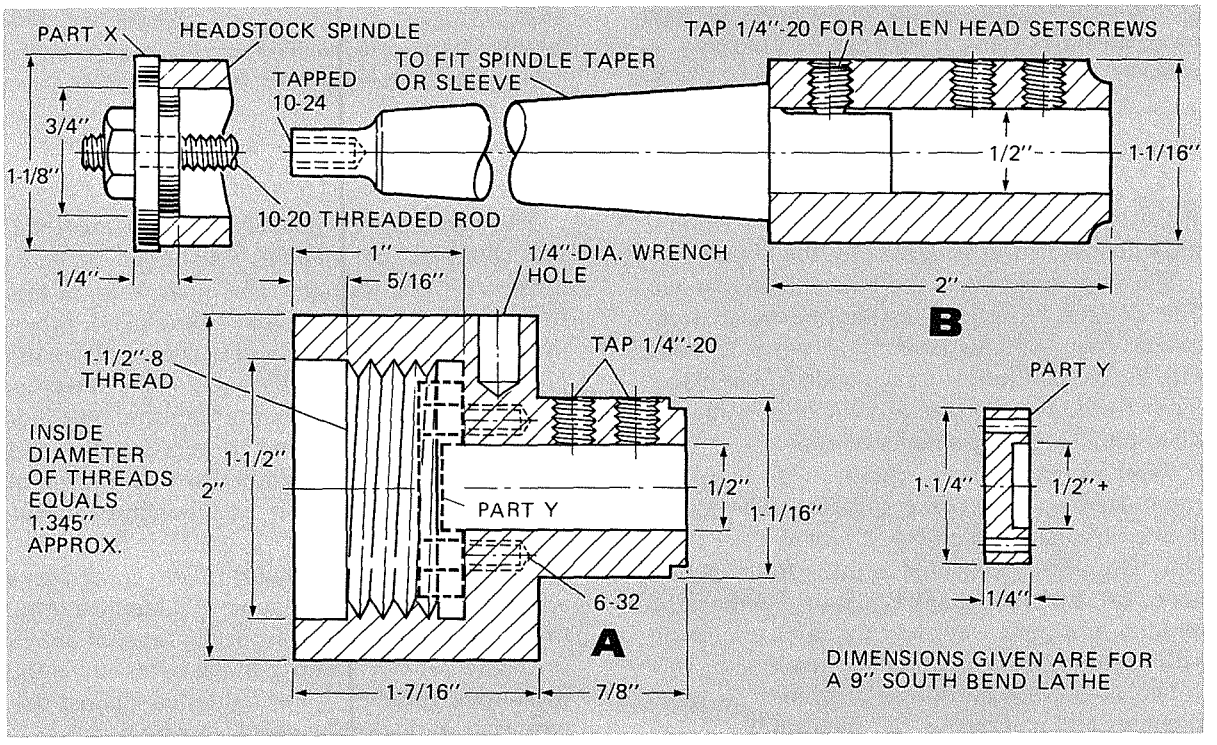
The internal thread is cut next. Care must be taken not to jam the end of the threading tool against the bore bottom. For each cut (average depth about 0.0025 in.), the lathe is stopped a bit short of the end, and the cut finished by pulling the headstock belt by hand. A 60° point threading bit is used.

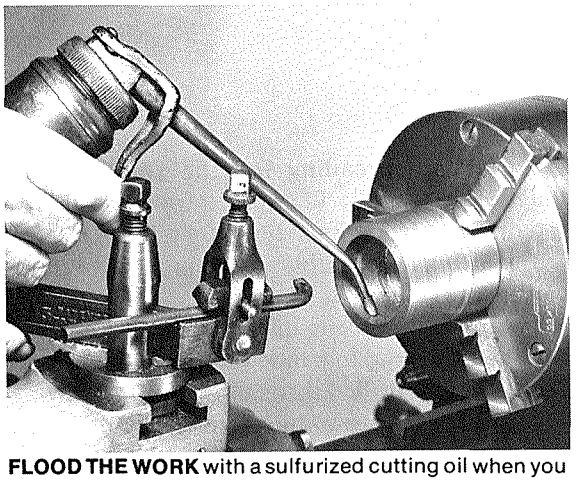
Careful measurements can produce a precise fit of threads, but a gauge threaded like the spindle nose is handy for testing the internal threads. For another test remove the lathe chuck without loosening its jaws, turn it and the setscrew-chuck blank end for end, and try to screw the blank onto the spindle.

When the threading fits the spindle nose snugly, remove the workpiece from the chuck and drill a radial wrench hole (for a ¼-in. rod) as shown. This hole enables the chuck body to be loosened readily.

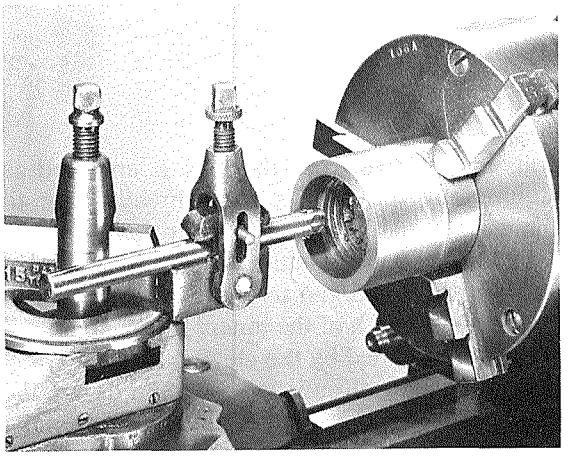
The chuck blank is installed on the spindle, and the outer end machined to the form shown. Then a hole is drilled through its center, starting with a small bit, to a diameter of about $^7/_{16}$ in. Because it is possible for a drill bit to produce a hole slightly out of line, a boring bar is used to bring the hole to final diameter of ½ in. This diameter depends on the tool-shank diameter and clearance necessary for easy installation or removal of the tool, and might be around 0.501 or 0.502 in. (Many cutting tools have precise ½-in. shanks.) Another way to achieve an accurate, true-running hole is by internal grinding. If such a chuck is hardened, final grinding would be done afterward.

After the outside surface has been smoothed with file and abrasive cloth, remove the chuck body from the spindle and drill and tap the two ¼-20 setscrew holes. Make an internal back-up disc (part Y) to help the setscrews handle end

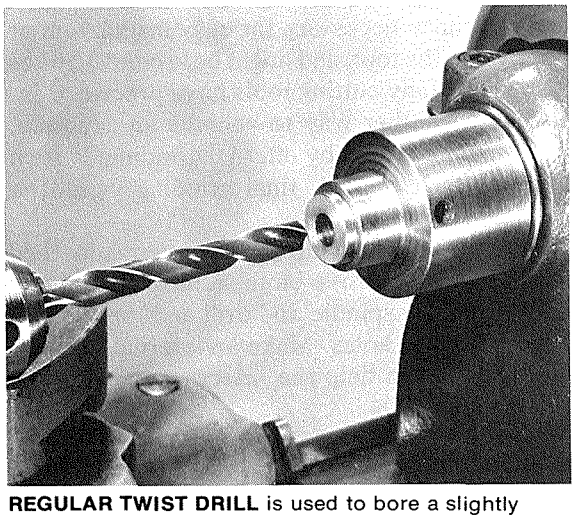




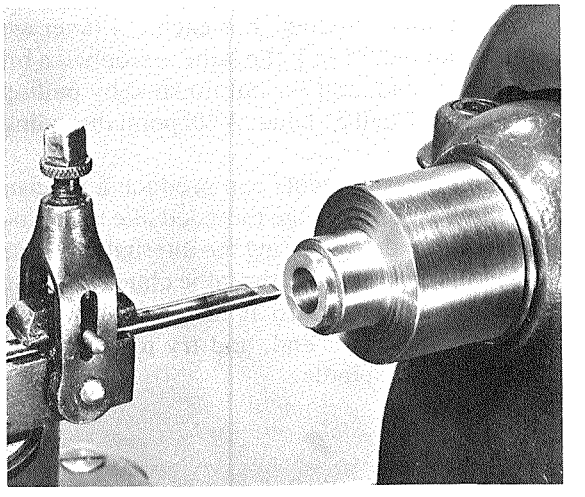
FLOOD THE WORK with a sulfurized cutting oil when you bore the spindle-nose recess in the chuck body.



AFTER RECESS is bored, 1½-in. x 8 threads are cut into the chuck body to fit the 9-in. lathe spindle.



REGULAR TWIST DRILL is used to bore a slightly undersized axial hole in the body of the screw-on chuck.



BORING BAR is used to finish-bore the axial hole. The hole in the side is for a chuck-removing wrench.

thrust such as that which is produced when a large-diameter drill is driven by the chuck.

The steel disc covers the hole and has an outside diameter that fits inside the headstock-spindle hole without jamming. Two 6-32 bolts with heads filed for clearance anchor it in place. (Four would be stronger.) Disc can be removed when chucking long shanks or rods.

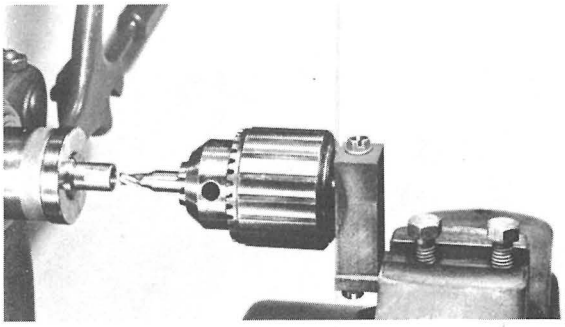
• **Taper-shank setscrew chuck.** This is sometimes used on drill-press spindles. The shank shown is from a broken No. 2 Morse taper twist drill. The drill is annealed and the flute section sawed off. Then the shank is installed in the lathe spindle, and punch-marked for later alignment with spindle sleeve and spindle itself.

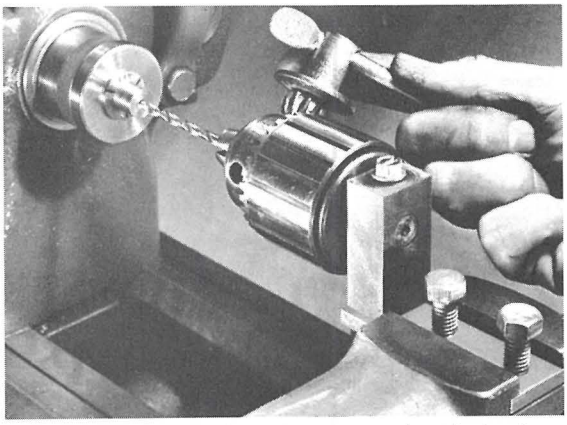
The projecting portion is machined to ½-in. diameter and a setscrew-flat filed on it.

The chuck body is made from 1⅛-in. steel rod. It is chucked, and an axial hole about $^{7}/_{16}$ in. in diameter bored through. The outer ¾ in. of this hole is bored so that the taper-shank end, previously machined to ½ in., will fit snugly. Then the piece is unchucked, and a hole for the setscrew that clamps it to the shank is drilled and taped for a ¼-20 thread. The two parts are assembled and installed in the lathe spindle for final boring of the ½-in. tool-shank hole, and finishing the surface.

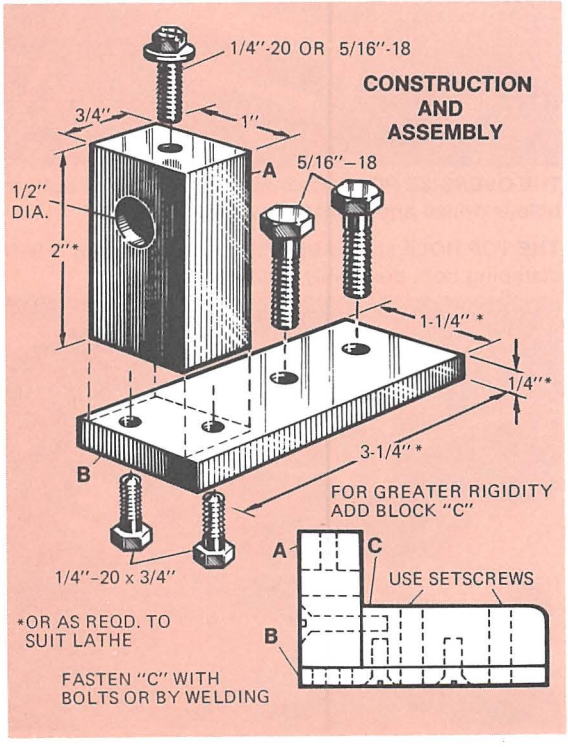
Because the taper shank might come loose when in use, a safety feature is added—a long, threaded rod extending from the tapered shank through a cap machined to fit the outer end of the headstock spindle. A nut tightened against this cap, part X, locks the shank in place.

A carriage chuck mount for your lathe





FIVE OF SEVEN attachment parts are short bolts. An optional eighth part is indicated as "C" below.



■ A DRILL CHUCK on a lathe carriage can be useful when your tailstock spindle is occupied by some other tool, or when you want to avoid juggling bits and chucks for certain operations. Or perhaps your only good drill chuck available has a straight arbor that cannot be readily adapted to the tapered hole in the tailstock spindle.

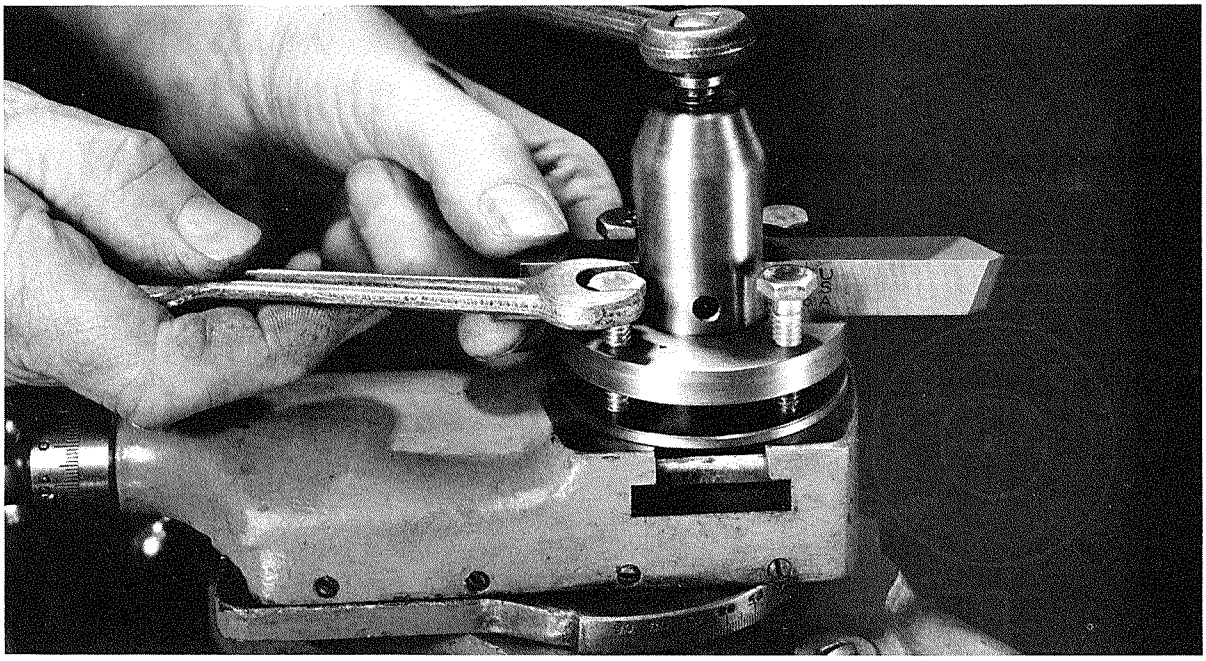
The horizontal part, "B" in the drawing, fits the toolpost slot of the compound slide and is clamped there by two $^{5}/_{16}$-18 bolts passing through it and bearing against the slot bottom. Moderate tightening of the bolts to force the bar up against the undercut parts of the T-slot locks it securely. Bar "B" projects beyond the slot enough to support the vertical piece "A." In the model, two ¼-in. bolts, running upward through "B" and engaging threaded holes in "A," hold the pieces together. Dimensions on the drawings are for an attachment to fit a 9-in. bench lathe. Vertical block "A" extends about ¾ in. above the lathe centerline. The ½-in. hole in this block accepts the ½-in.-diameter stub arbor of the drill chuck used. This hole coincides with the lathe axis. To position it properly, the assembly was clamped in the T-slot, with an edge of bar "B" pressed firmly against one side of the slot, and "A" (or the head of one of the bolts below it) tight against the side of the compound slide. The slide was set at exactly 90° to the lathe axis.

The attachment shown is intended for drilling, reaming, countersinking and similar operations using bits aligned with the lathe centerline and having opposed, or "balanced," cutting edges. Light boring can be attempted with a boring bar or tool having offcenter action.

There should be no chatter trouble using the chuck to hold a marker for scribing circles on faceplate-mounted work, or for cutting circles in cardboard with a knife-edge bit (the material being on a faceplate perhaps turned by hand).

SEE ALSO

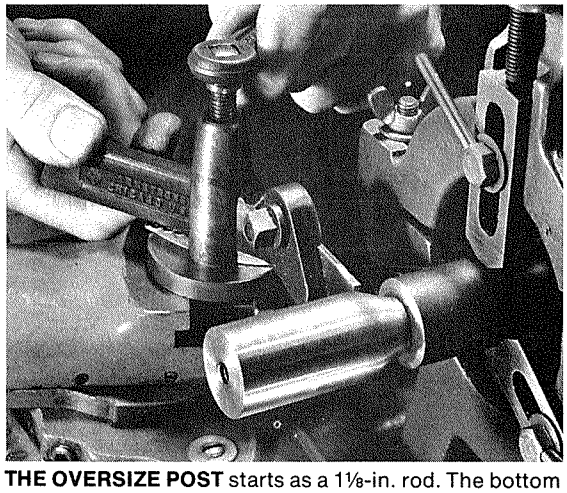
Drill presses . . . Drill-press accessories . . . Metal-lathe techniques . . . Tools, hand



Make a king-size toolpost

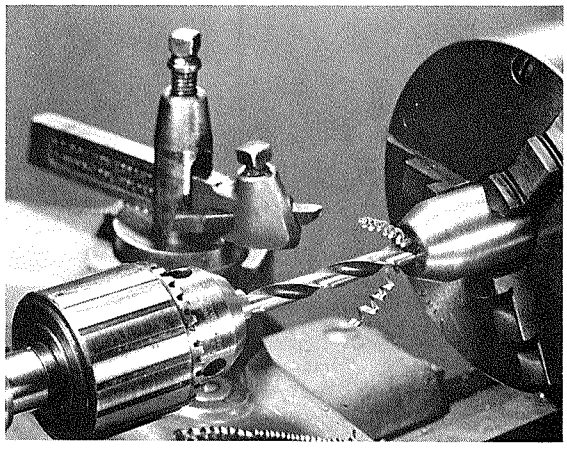
High-speed steel or carbide bits are better for some jobs on a small lathe. The problem is finding a toolpost to accommodate them. The solution is to make your own.

■ HEFTY, HIGH-SPEED steel or carbide bits are more rigid and in other ways superior to the toolholder-bit combination widely used on small lathes—but a conventional toolpost has too narrow a slot to accommodate them. Even if the slot were wide enough, some sort of block or shim system would have to be improvised to position cutting edges at the proper height.

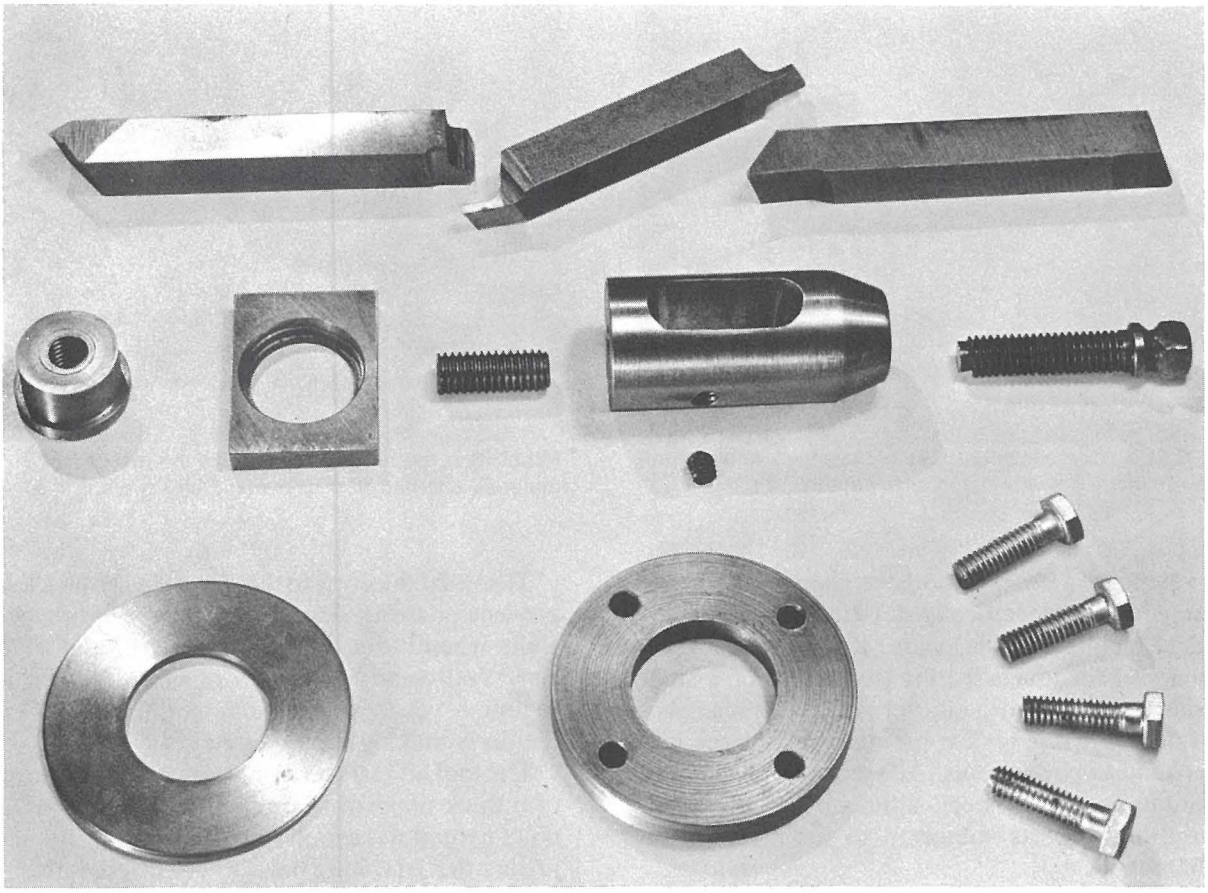


THE OVERSIZE POST starts as a 1⅛-in. rod. The bottom hole is drilled and tapped for a mounting stud.

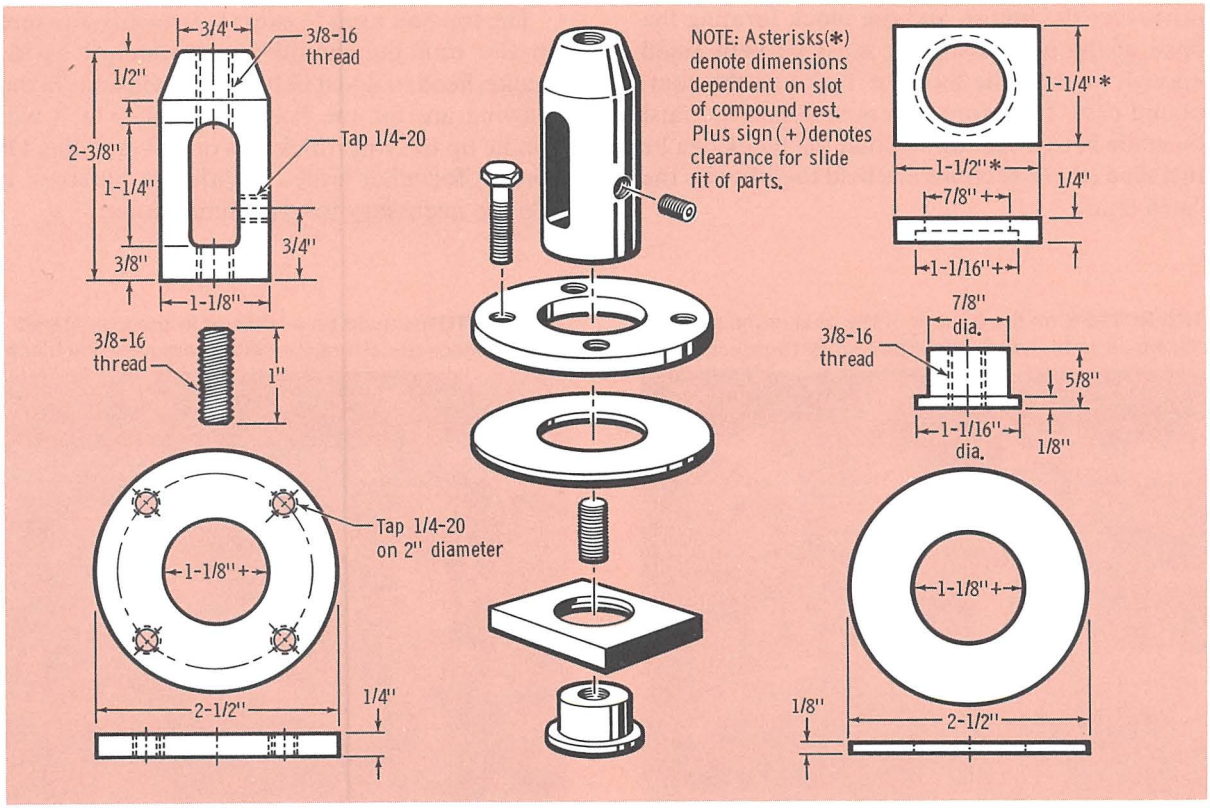
THE TOP HOLE should be drilled and tapped for a ⅜-16 clamping bolt, preferably with a square head.

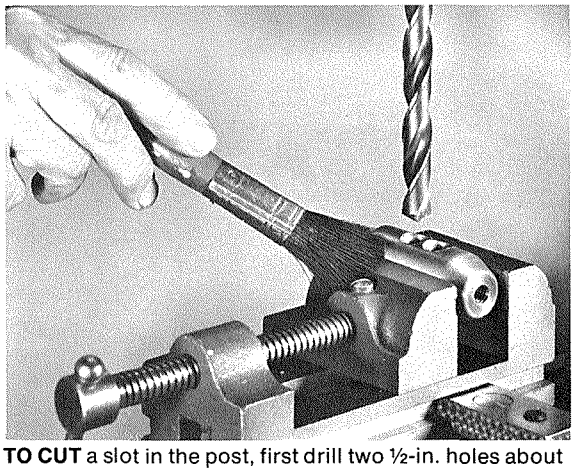


SEE ALSO
Metal-lathe techniques . . . Tools, hand

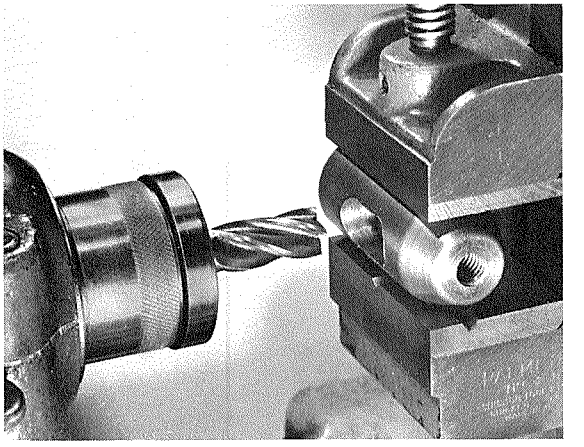


EASY-TO-SHAPE PARTS go together as shown in the exploded view below. Two setscrews may be needed.





TO CUT a slot in the post, first drill two ½-in. holes about ¾ in. apart (measured center to center).



MILLING is the best way to remove the rest of the material. Alternately, excess could be sawn and filed.

Not so with the toolpost shown, however, since it was specifically designed to accommodate bits up to ½-in. wide. It has an easily set height-adjustment feature consisting of a steel ring supported by a quartet of bolts. It also provides firm support for boring bars or large bits ground as boring tools. All parts can be made of ordinary or tool steel, although for maximum durability, parts subjected to wear should be hardened.

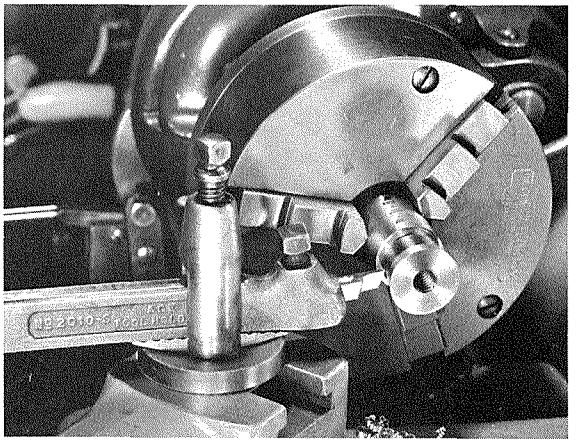
Because of the wide tool slot, the diameter of the post is greater than that of the conventional post—yet the button and the block forming the base of the post assembly must be kept small enough to enter the toolpost T-slot on the compound rest. Therefore, the post assembly must be made in two sections so that the block can be installed (these sections are held together by the ⅜-16 stud).

The ¼-20 setscrew in the side of the holder will prevent possible side shifting of the bit, especially when it does not completely fill the wide slot. You could install two or more screws, if required, which would be most effective when the bit is making heavy side cuts.

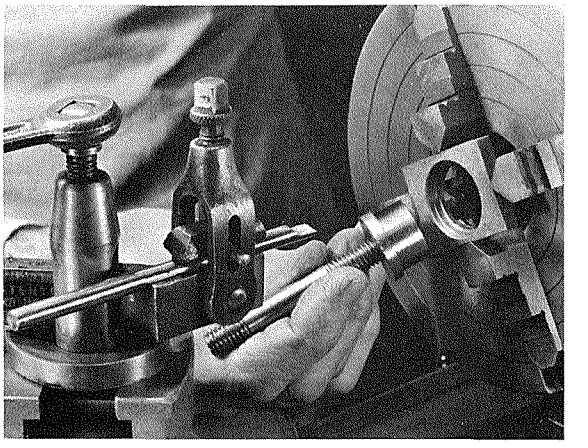
The tool bit rests on a ring assembly consisting of a thick upper ring through which four ¼-20 bolts extend to rest on the thinner ring. By adjusting the 1-in.-long bolts to control the height of the upper ring, it's possible to set the bit at the proper cutting height.

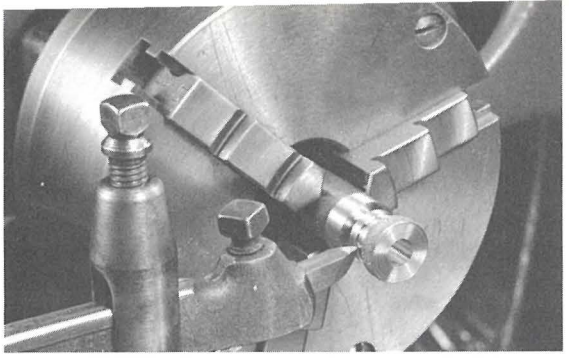
The top bolt used to exert downward pressure on the tool bit should be a standard ⅜-16, square-head toolpost bolt. The dimensions in the drawing are for the holder shown, which will handle up to ½-in.-thick bits on a 9-in. lathe. Of course, for other lathes or different bit sizes, it may be necessary to vary dimensions.

THE BUTTON on the bottom of the post assembly is machined to fit T-slot, then fitted on ⅜-16-thread stud.



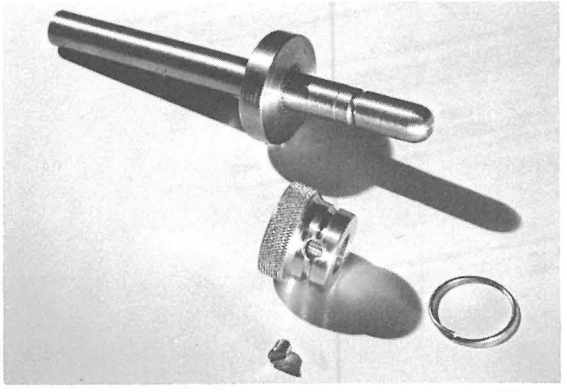
THE BUTTON should be a loose fit in the shouldered block. Check the clearance before removing the block.



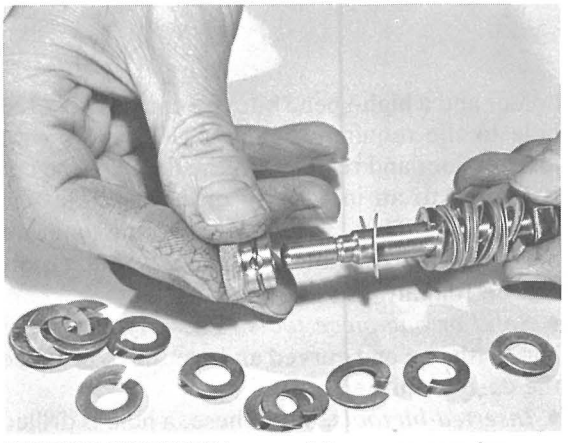


Solve holding problems with a threadless nut

By B.W. ERVIN



ESSENTIAL PARTS: grooved rod, knurled nut with a hole for the pin and a groove for the wire spring.



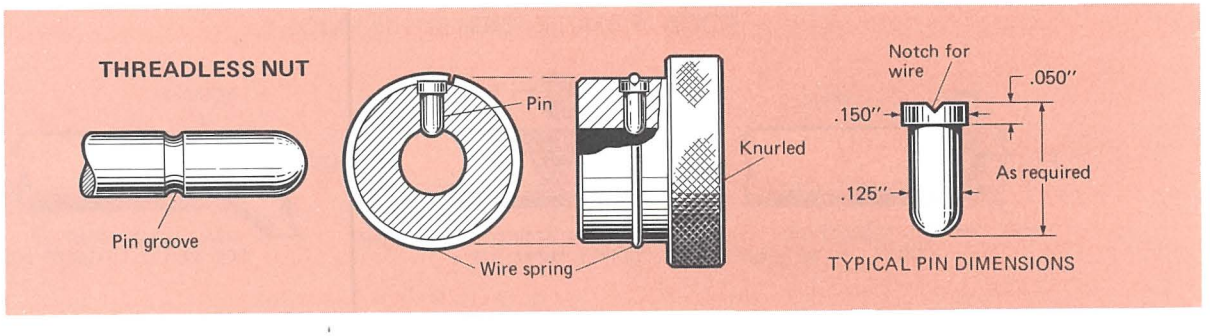
STORING WASHERS is one of the many uses for push-pull nut; it's handy way to carry them in toolbox.

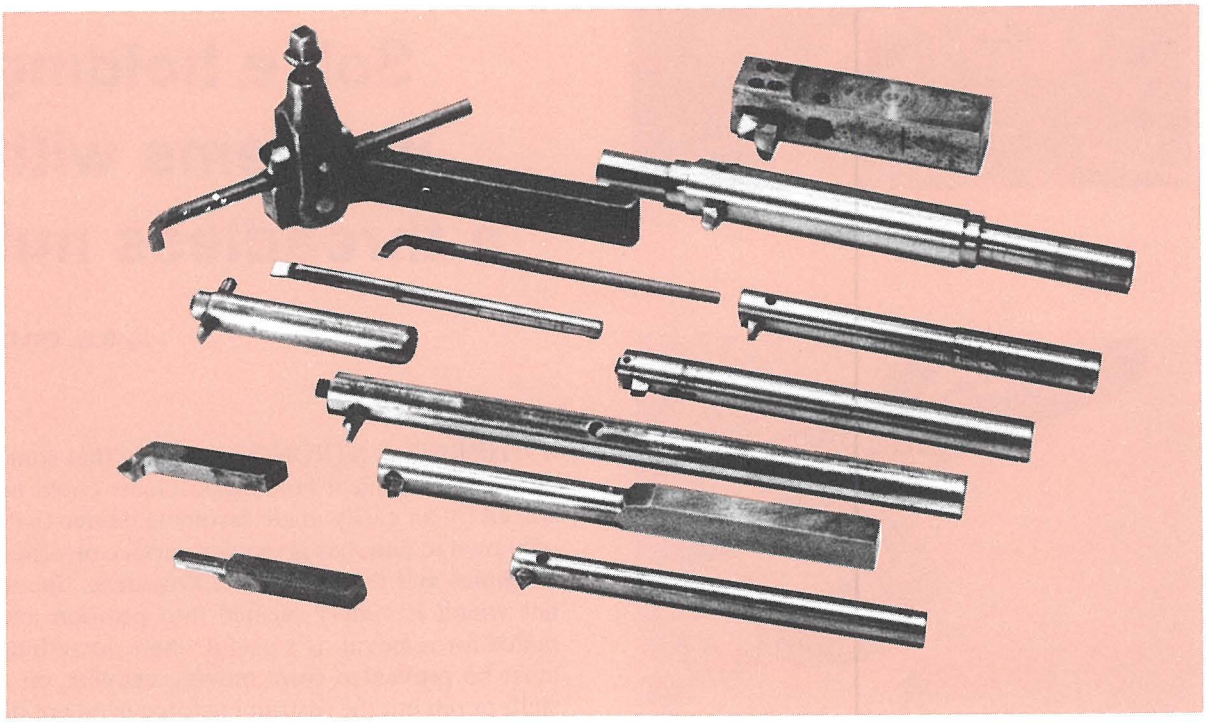
■ THERE'S A STRONG possibility that some of your mechanical holding problems could be solved by an easily made fastening device that, unknown to you, has given you service on office machines and the like. It is a threadless thumb nut which is simply pushed into position and pulled for removal. It's useful where something must be prevented from moving endwise on a shaft or pin but the restraining force need not be great, or where an adjustable stop is needed to indicate certain fixed positions or dimensions.

The nut has a smooth (unthreaded) hole sized to slide freely without excessive play, over the shaft rod or stud that is its "bolt." A ring-shaped wire spring resting in a groove around the outside of the nut seats a round-nose pin in a radial hole extending into the center bore. Pin and hole are tapered for an easy sliding fit, and dimensioned so the rounded-pin nose extends a fraction of an inch into the nut bore when the pin is fully seated. To install the nut, you simply push it onto the shaft, whose rounded end forces the pin outward; when the pin reaches the shaft groove, it moves inward and stops the nut in that position. To shift or remove the nut, simply apply enough force (parallel to the rod) to move the pin back out of the groove.

SEE ALSO

Metal-lathe techniques . . . Tools, hand





How to make and use lathe boring tools

By WALTER E. BURTON

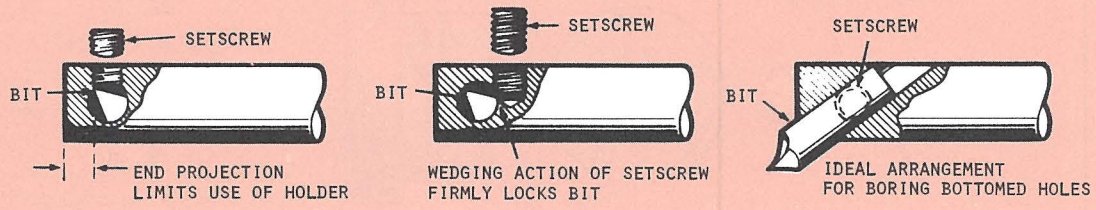
■ YOU CAN'T USE a lathe too long before running into some boring work—not monotonous, but "boring" as a means of increasing the diameter of a hole.

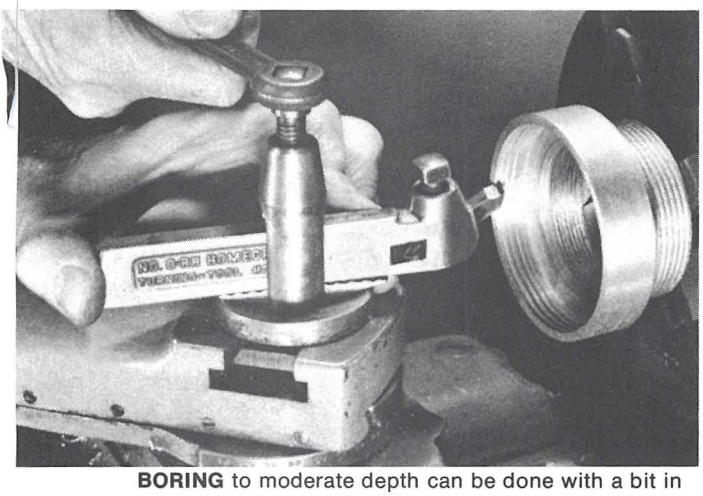
Boring customarily begins with a pilot hole, either drilled into solid stock or the inner diameter of a tube. Then using just the regular toolholder and a high-speed bit, you can bore out the hole to the required diameter. However, with just a holder and regular bit, the depth of the cut is limited to an inch or so on a moderate-size bench lathe. Thus, special lathe boring tools are needed to increase the depth of cut. Such tools can be roughly classified as follows:

- *Solid or one-piece tools*. These typically are bars with one end curved and ground to produce the desired cutting edge.
- *Inserted-bit tools*. With these, a hole is drilled in the end of a round or square holder to accept either a round or square bit. A setscrew or other arrangement is used to lock the bit in the hole.

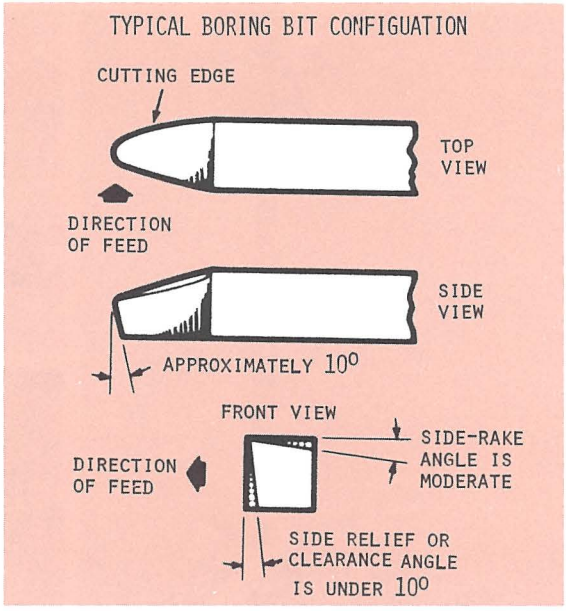
SEE ALSO
Angles, drilling . . . Metal-lathe techniques . . . Tools, hand

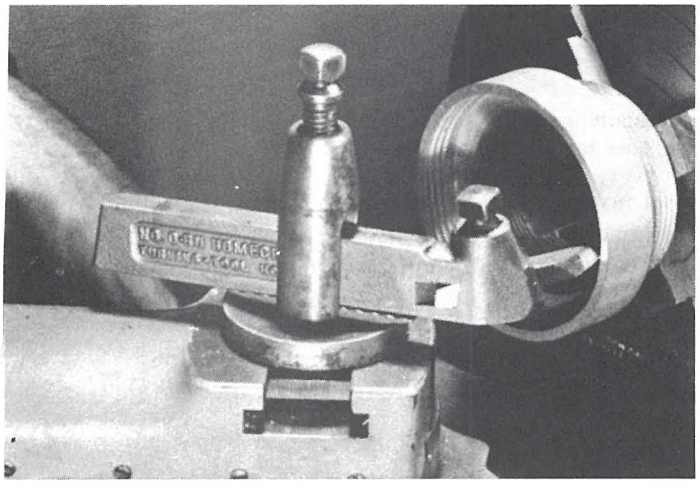
METHODS OF MOUNTING BORING BITS IN HOLDERS

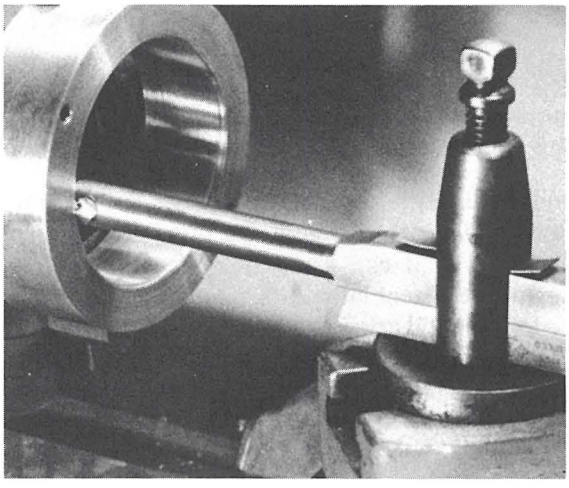




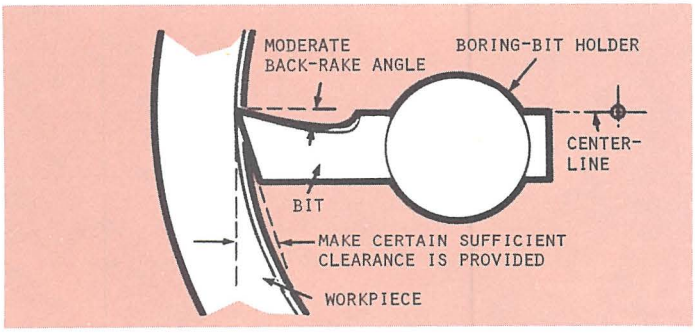
BORING to moderate depth can be done with a bit in regular holder (top), but it's easier to watch cutting on opposite side (below). Modified bits (top right) are used in regular, special holders (below right).







The advantages of this particular type of boring tool are many: the bit can be removed easily for sharpening or replacement; the boring tool can be made reversible with both ends fitted for different bits.

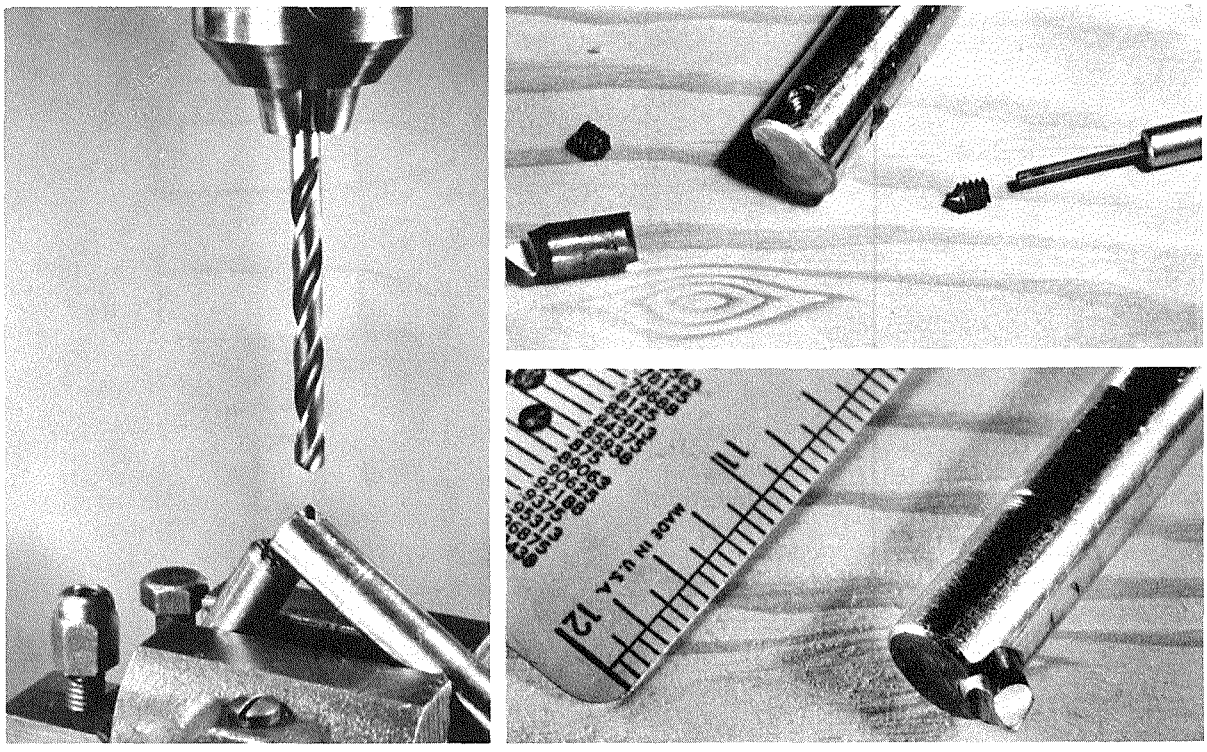


• *Inserted-bit boring bars*. These are usually intended for mounting between centers or between a chuck or tailstock center. Often they will have more than one inserted bit for boring two or more diameters at the same time.

Among the easiest boring tools to make are center-supported boring bars and boring tools that mount in the regular toolpost, or in a holder that fits or replaces the toolpost.

Drill the mounting hole through the end of the rod (either straight through or at an angle) and drill and tap a second hole for a setscrew. This way, you can use round bits made from the shanks of broken twist drills or other suitable stock. If you would rather use square bits made from standard lathe-bit blanks, simply file the drilled hole until it's square.

For boring very small holes, a solid, one-piece



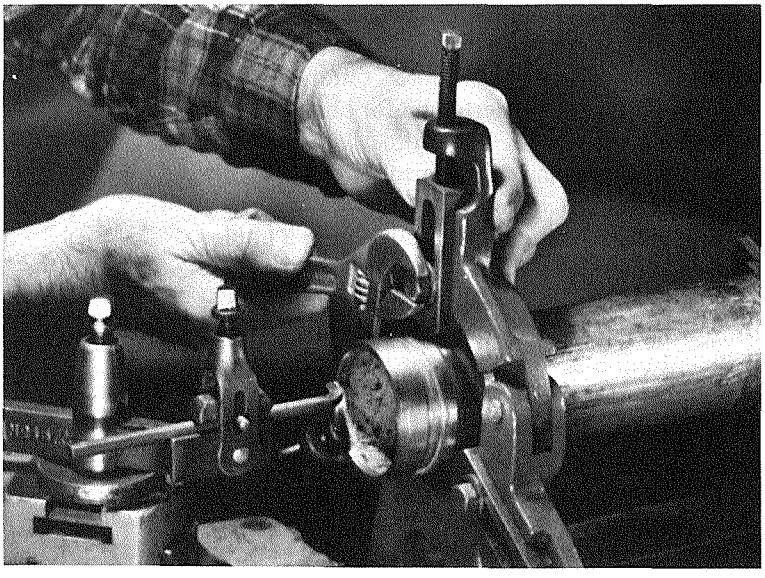
BORING TOOLS for bottomed cuts must have bit inserted at an angle so cutting edge projects beyond the holder. The three steps shown above illustrate a typical tool made of ½-in. steel bar and ¼-in. diameter bit.

tool generally is used. You can forge, file or grind such tools from tool-steel stock and then harden them; or you can grind them from hardened high-speed-steel lathe bits.

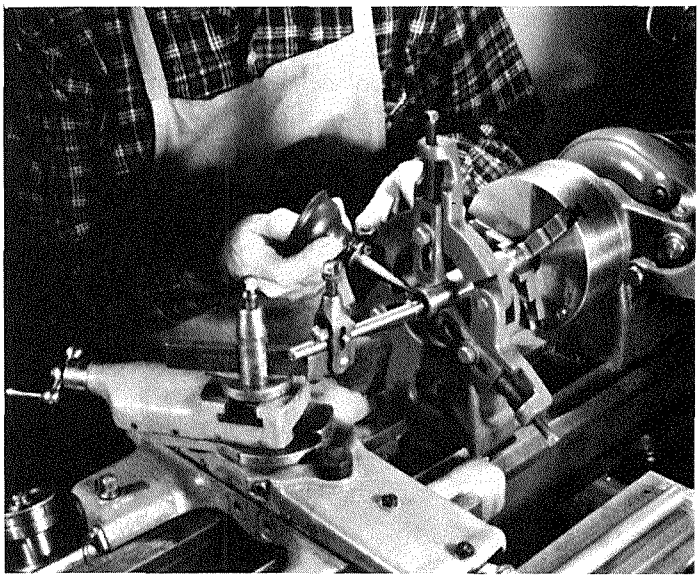
Dependent upon the particular job at hand, boring tools can be mounted directly in the toolpost, in a holder clamped to the toolpost, in a rigid holder that replaces the toolpost, or in a milling vise mounted on the lathe carriage. There are also boring units that can be mounted on the tailstock spindle or gripped in a headstock-spindle chuck.

An inserted boring bit or a one-piece boring tool can be ground in the same manner as a

WHEN BORING long cylindrical work, run one end in the steadyrest and mount the other end in the chuck.



TO TAPER-BORE a hole, use a taper attachment (foreground), mount outer end of work in steadyrest.



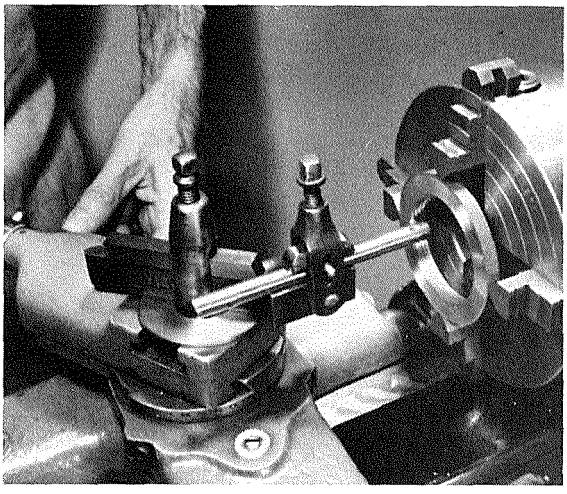
conventional bit, although it will require more clearance and less rake since it will be cutting into a concave surface. Thus, for all-purpose tools, front or end clearance should be 10° to 20° as determined by the radius of the bore. Side clearance should not exceed 10°; the angle of the end cutting edge should be approximately 10°, and the side rake and back rake will be about half that of conventional bits. Bits for boring brass, however, or those used to cut threads should have zero rake.

For aluminum, steeper side and back rakes are desirable.

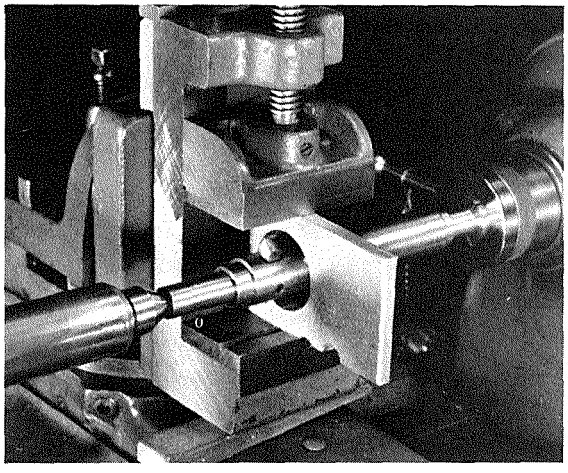
Rings, short cylinders, nuts, washers, plates and other items of moderate thickness generally are mounted in a chuck or faceplate. Always keep in mind that there must be enough clearance behind the work so the boring bit can pass through the work without jamming.

Long pipes, tubes, rods and other cylinders too large to extend back through the headstock-spindle hole can be bored with the aid of a steadyrest. Here, one end will generally be clamped in a chuck, although it also is possible to use a headstock center and dog, the dog being lashed securely to the faceplate with cord or wire to prevent endwise shifting. Then the end to be bored rotates inside the trio of steadyrest jaws.

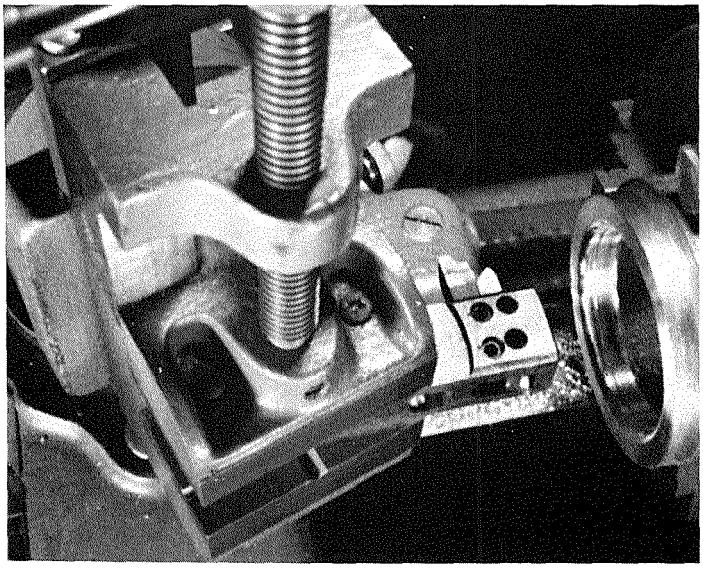
When a center-supported boring bar is used, the workpiece is mounted on the lathe carriage. This is a useful setup for aligning two or more holes. The work can be mounted in a milling attachment or in a jig clamped to the carriage. Of



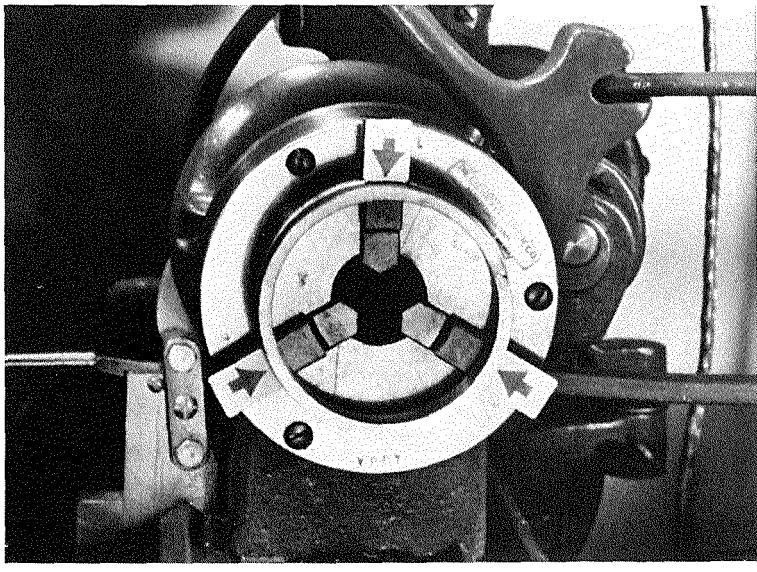
CUTTING INTERNAL threads (above) is a boring function. The bit is aligned with center and the feed is closely controlled. Large hole in plate (below) can be converted to oval by varying amount of cross-feed.

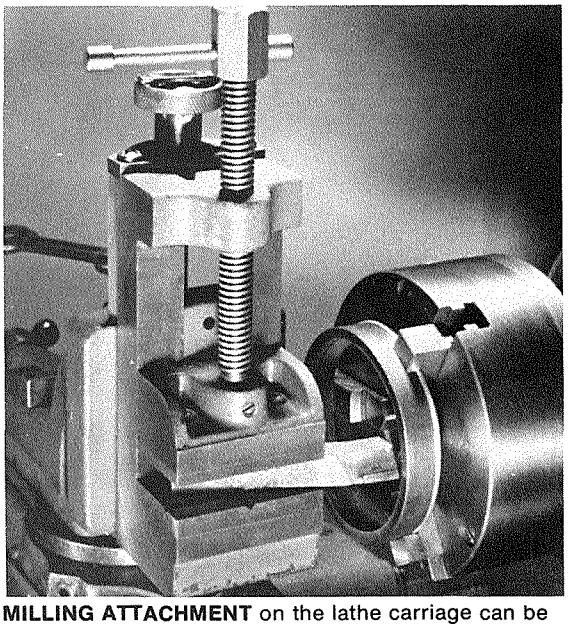


DOUBLE-BIT tool is shown clamped in a milling attachment, but also could be mounted on a carriage.

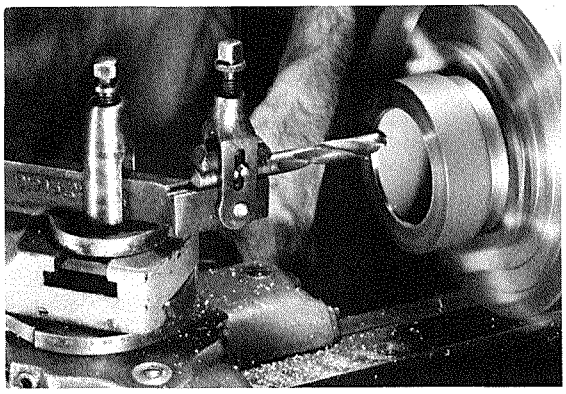


JAW PRESSURE indicated by arrows produces out-of-round holes in thinwall tubes. Use different mounting.



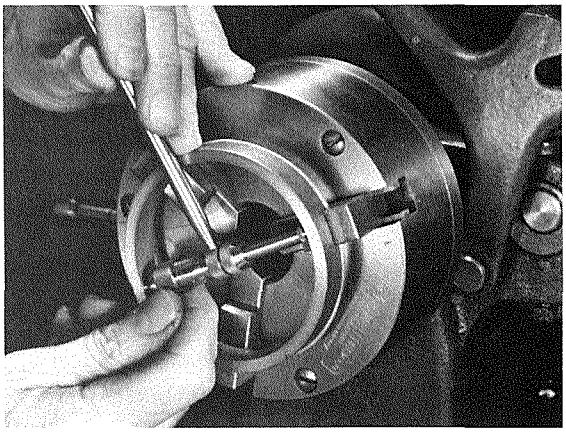


MILLING ATTACHMENT on the lathe carriage can be used as a holder for oversize tungsten-carbide bit.



FOR SIMPLE JOBS, an old drill bit mounted in the toolpost holder will do just as well a boring bits.

INSIDE MICROMETERS are invaluable when it comes to checking of tolerances for precision boring.



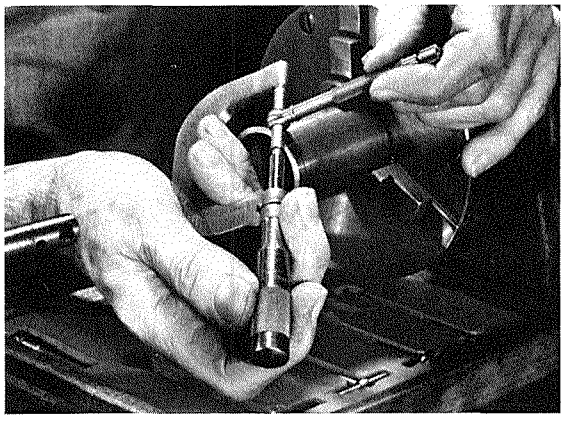
course, accurate vertical positioning—with the help of shims, if necessary—is very important to assure exact alignment.

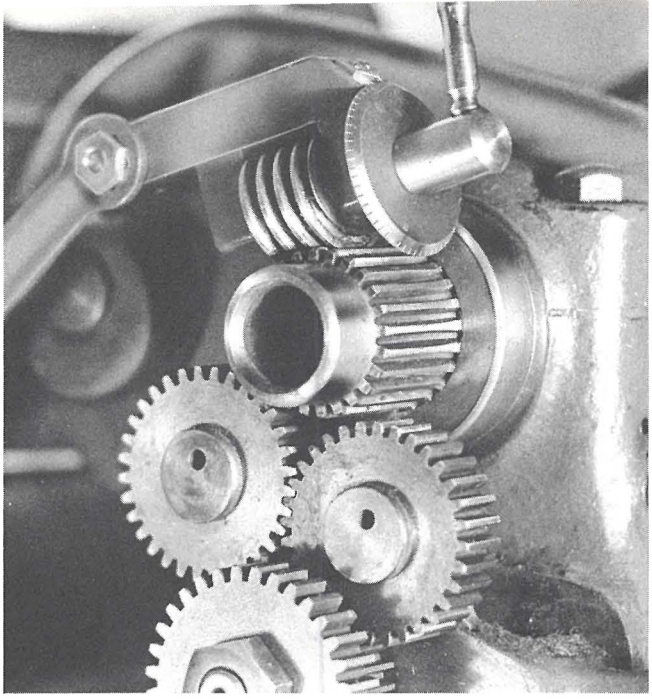
Keep in mind that the chuck-jaw pressure on a ring, especially if it's thin-walled, can make it impossible to produce a truly round bore. This condition can be minimized by using no more jaw pressure than absolutely necessary, or by clamping the workpiece in a faceplate-mounted or chuck-mounted fixture that applies pressure evenly.

At optimum spindle speed, the boring tool will cut smoothly and without excessive effort. However, because of the various conditions encountered with every job, the best way to determine the optimum speed is to start slowly and increase it in steps. As soon as chatter occurs, decrease the speed.

Similarly, feed also must be controlled so that material is removed cleanly and smoothly. Here again, the best practice is to begin slowly and then work upward.

TELESCOPING GAUGES are used to check the inner diameters of smaller work. Tighten the knob to lock the arms of gauge (below left), then remove the gauge, use micrometer to accurately measure diameter (below right).





Make a lathe indexing attachment

By CHARLES J. KSANDA

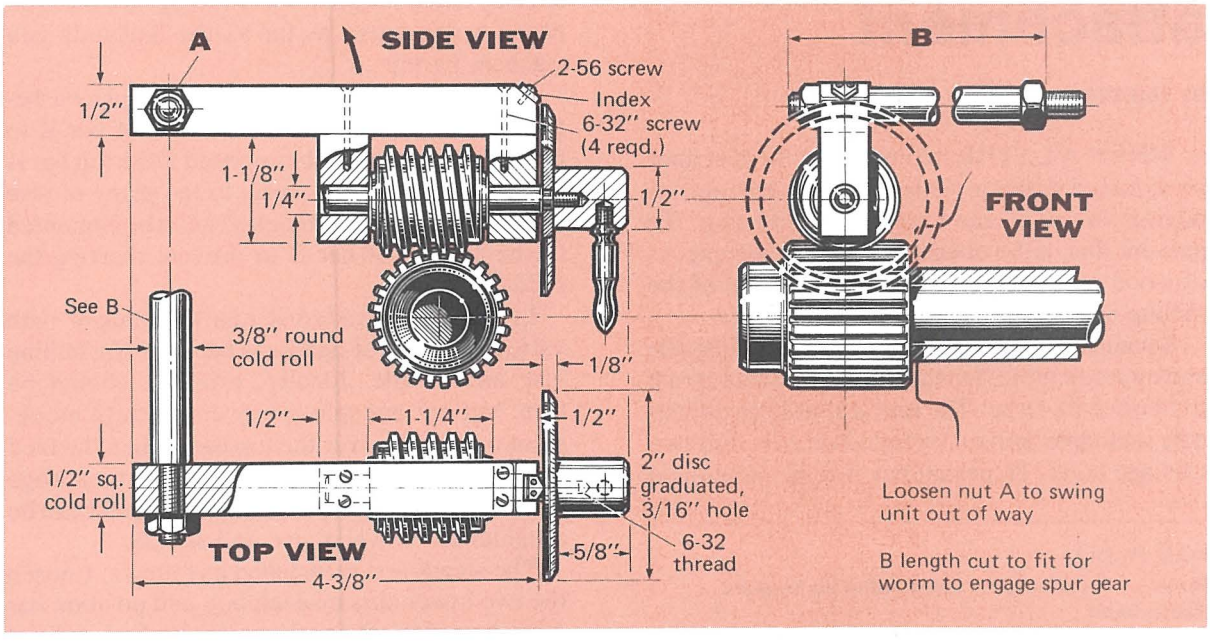
■ THIS SIMPLE lathe indexing attachment is perfect for precision circular dividing and angular indexing. You can make it yourself.

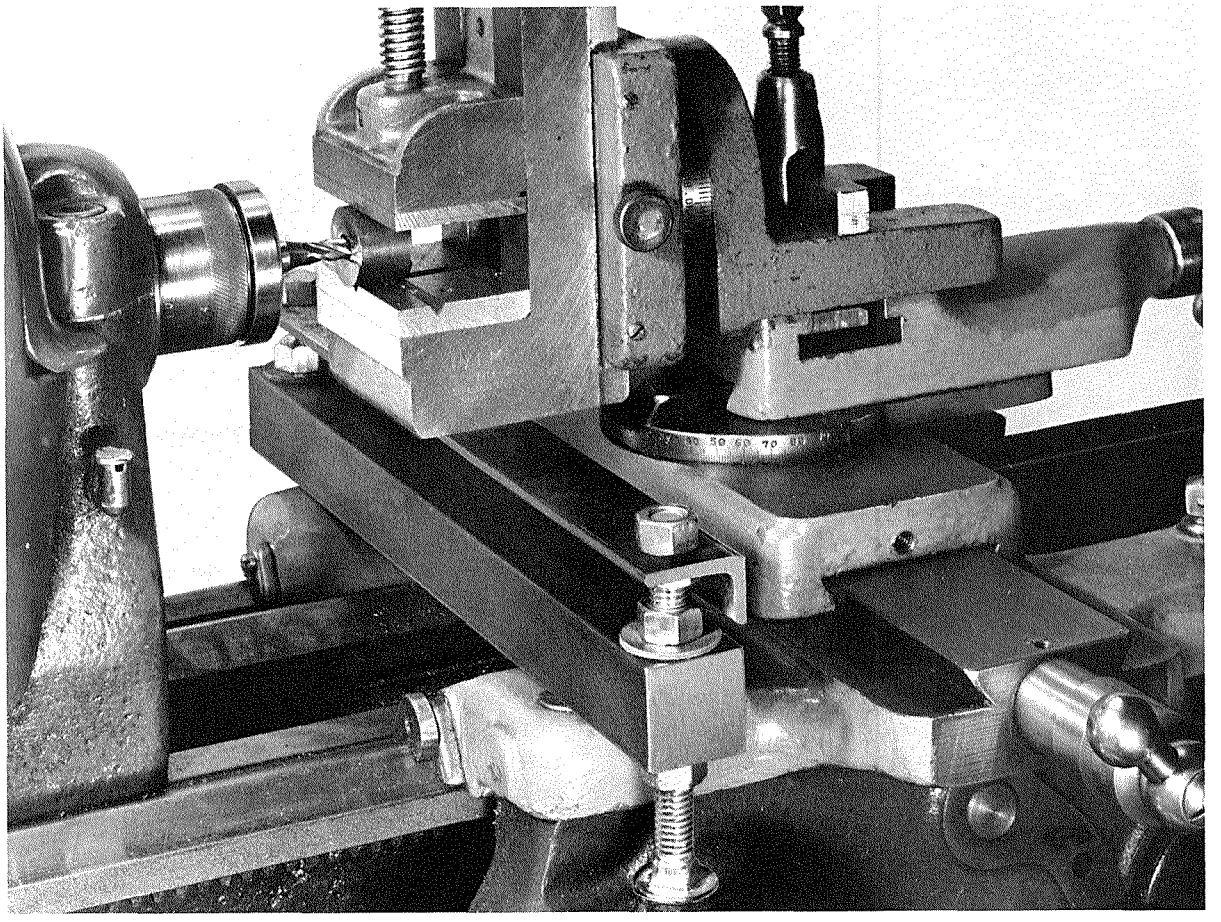
The attachment consists of a U-shaped bracket which holds a single-thread worm, or tangent screw, graduated dial disc and an index that permits accurate settings. The unit is permanently mounted on the headstock of the lathe with a single bolt. One turn of the tangent screw turns the spindle 15° (since the spur gear on the spindle has 24 teeth).

The attachment is fitted with two dial discs: One is divided into 60 parts, the second into 90. Between the two, you can graduate a circle to within ¼ to 1/6 of one degree. With appropriate setting of the dial, the circle can be divided into any even or odd number of parts.

The drawing (side view) shows the tangent screw engaged in the spindle spur gear. Directly below, the latter is shown when not in use. To engrave the lines, use a cutting tool mounted on the compound slide and determine the length by using the micrometer scale on the cross-feed screw.

SEE ALSO
Metal-lathe techniques . . . Tools, hand





THE STEADYREST placed across the saddle provides support to the overhanging vise of the milling attachment.

Steadyrest for a lathe milling attachment

By WALTER E. BURTON

WHEN A LATHE milling attachment cannot be mounted without considerable overhang, annoying vibration and chatter can develop. To prevent this, lathe operators often wedge pieces of wood or metal between the lower end of the milling-attachment vise and the carriage.

Because such makeshift wedging is unstable and unpredictable, I made this milling steadyrest to fit my 9-in. lathe. The rest is simply an adjustable rectangle formed by two steel bars and two carriage bolts. To permit bar A to be positioned close to bar B, I cut the nuts directly under it to about half thickness. Even greater travel is possible by machining a rabbet the length of bar B so angle A can move as far as the half nuts and washers permit.

The washers are leather and are placed between the nuts and the top surface of bar B to provide "give," which is needed if the top bar is not quite level with respect to the plane of vise movement. A thin leather layer can be cemented to the bottom of bar B to prevent marring the saddle's finish.

In use, the steadyrest can be wedged with various degrees of tightness between the milling vise and saddle. Ideally, pressure should be firm, but not enough to prevent smooth movement of the vise over the top bar. When the feed is accomplished by moving the entire carriage (with slides not operating), the steadyrest can be a tighter fit between vise and saddle.

The steadyrest is installed as follows: Loosen the two lower nuts on each bolt and position bar B on the saddle. Raise the upper bar by hand and

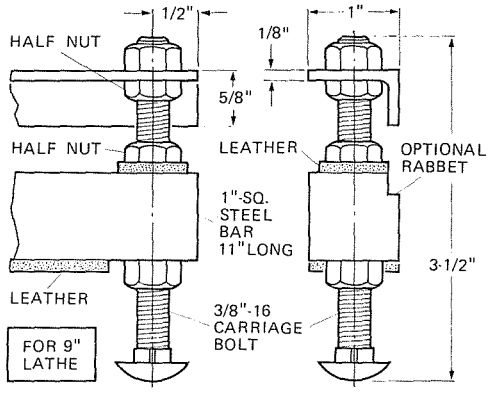
SEE ALSO
Bolts . . . Machining . . . Metal-lathe techniques . . . Tools, hand

hold it against the vise while the loosened nuts are tightened by hand. Then adjust the nuts at each end of bar B with a wrench so that bar A presses uniformly against the lower surface of the vise and pressure is adequate without interfering with horizontal movement of the workpiece. Too much divergence from parallelism between bar A and the plane of vise movement can lead to "jamming," thus affecting the accuracy of the cut by forcing the vise assembly upward.

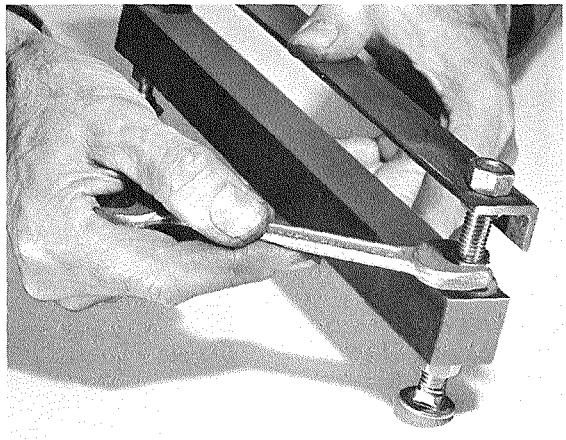
Each complete turn of a 16-thread nut shifts position 0.0625 in.

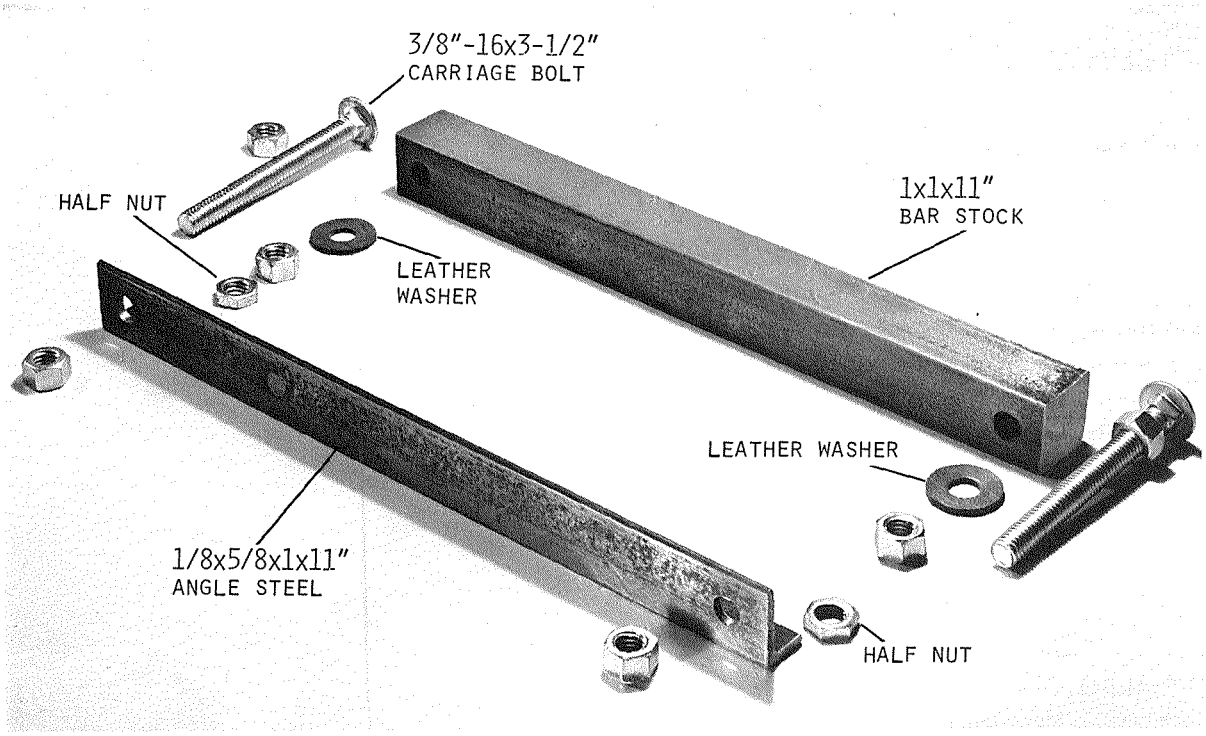
The steadyrest is intended primarily for use in operations that involve horizontal movement of the workpiece, such as end-milling a slot in a block or bar, or cutting a chamfer or groove along an edge. Direction of cutter rotation with respect to the workpiece movement can be a factor. You may notice immediately that the steadyrest is particularly effective when the cutter tends to force the workpiece down against it.

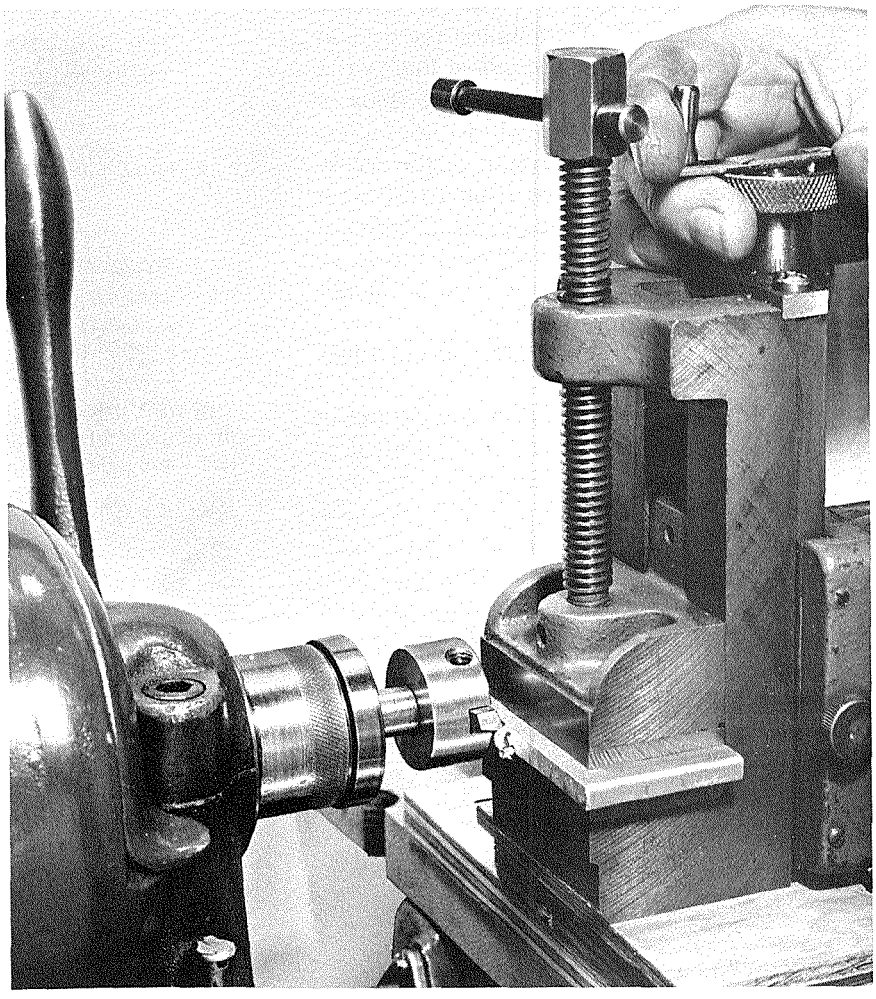
When milling in a lathe, you should remember two things: Always make certain that the workpiece is clamped securely, and that the milling attachment and compound slide (if the attachment is mounted over the toolpost slot) are firmly fastened to discourage horizontal shifting.



THE WEDGING ACTION of the steadyrest is achieved by moving the nuts at each end which bear against the lower bar. Final adjustment is made with the rest in place.







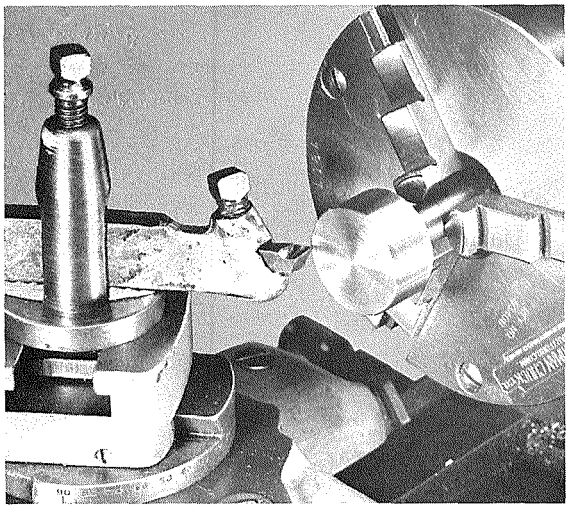
FLY CUTTER in a 9-in. lathe is smoothing edge of a ¼-in. aluminum plate held in a milling vise.

Make a fly-cutter holder

By WALTER E. BURTON

For some boring jobs this simple homemade fly cutter will prove to be a valuable aid. It's made from a standard high-speed-steel lathe bit clamped in a holder cut from a steel rod

AFTER THE SHANK is turned, the head of the holder is then machined and faced in a three-jaw chuck.



SEE ALSO
Machining . . . Metal-lathe techniques . . . Tools, hand

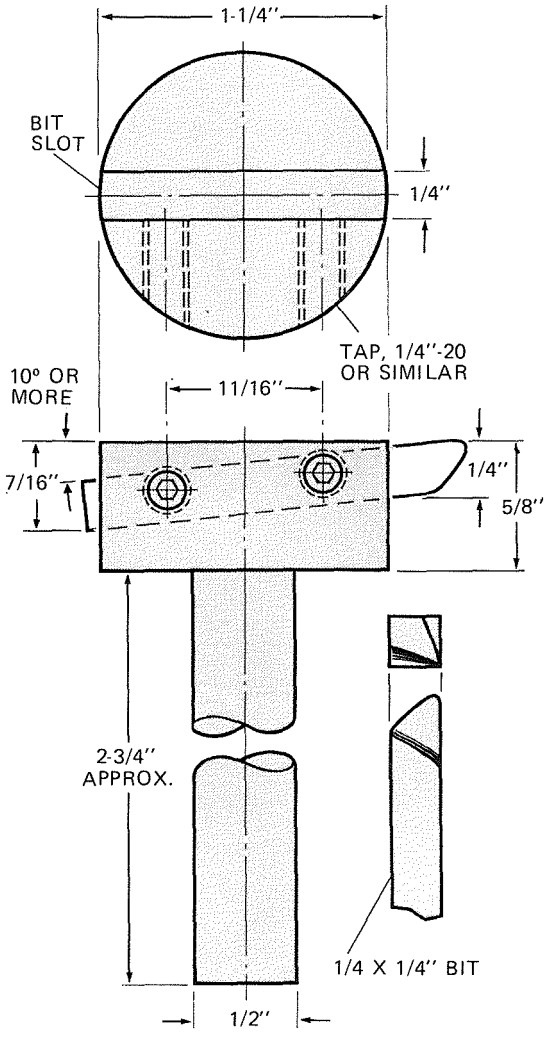
■ THIS SIMPLE shop-made fly cutter will do the work of an expensive multitoothed milling cutter. It's particularly useful for facing operations on workpieces that are held in a milling-attachment vise, and for certain boring jobs.

The tool consists of a standard ¼ x ¼-in. high-speed-steel lathe bit clamped in a sloping slot in a rotatable holder. The sloping slot positions the bit so its cutting tip is beyond the face of the holder. The tip is ground much like that of a conventional lathe bit.

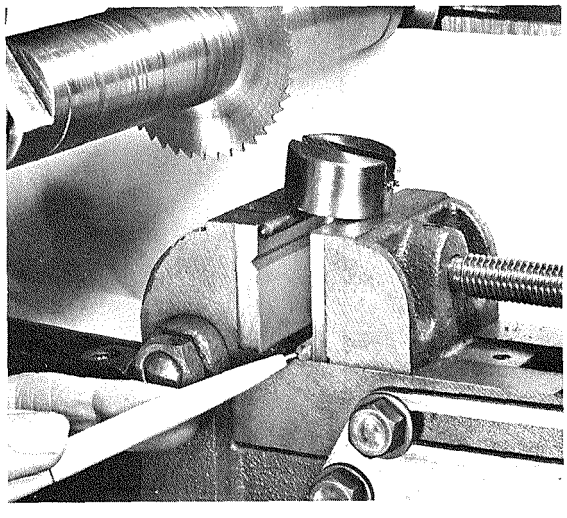
In a typical setup, the tool and holder are mounted in a headstock chuck and the workpiece is clamped in the vise of a carriage-mounted milling attachment. Because the work should be held as rigidly as possible, the overhanging vise is steadied by placing wooden blocks under it. Here the vise is run down against the top block, but not so tightly that the cross feed can't be used to move the workpiece past the cutter. Generally it is desirable to take rather shallow cuts and feed the work gradually and evenly, with the lathe at a slow or medium speed. Often the resulting surface is so smooth no further finishing is required.

The tool is made by turning down a length of 1¼-in. steel rod to form a ½ x 2¾-in. shank with a ⅝-in.-thick head, then cutting a ¼-in.-wide slot ($^3/_{16}$ in. deeper at one end than the other) across the face of the head. Two holes are drilled and tapped for setscrews that lock the cutting bit in its slot.

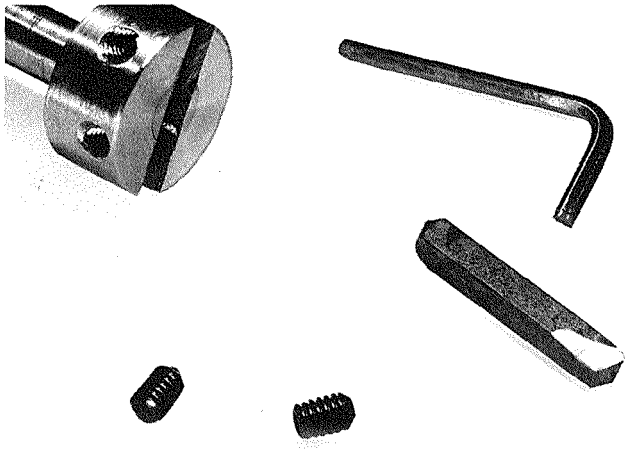
Since fly cutters have been known to throw chips, it's always wise to wear safety goggles or a face mask and to keep your shirt collar tightly buttoned.



THE HEAD is tilted to mill a sloping slot by placing two twist drills between the shank.

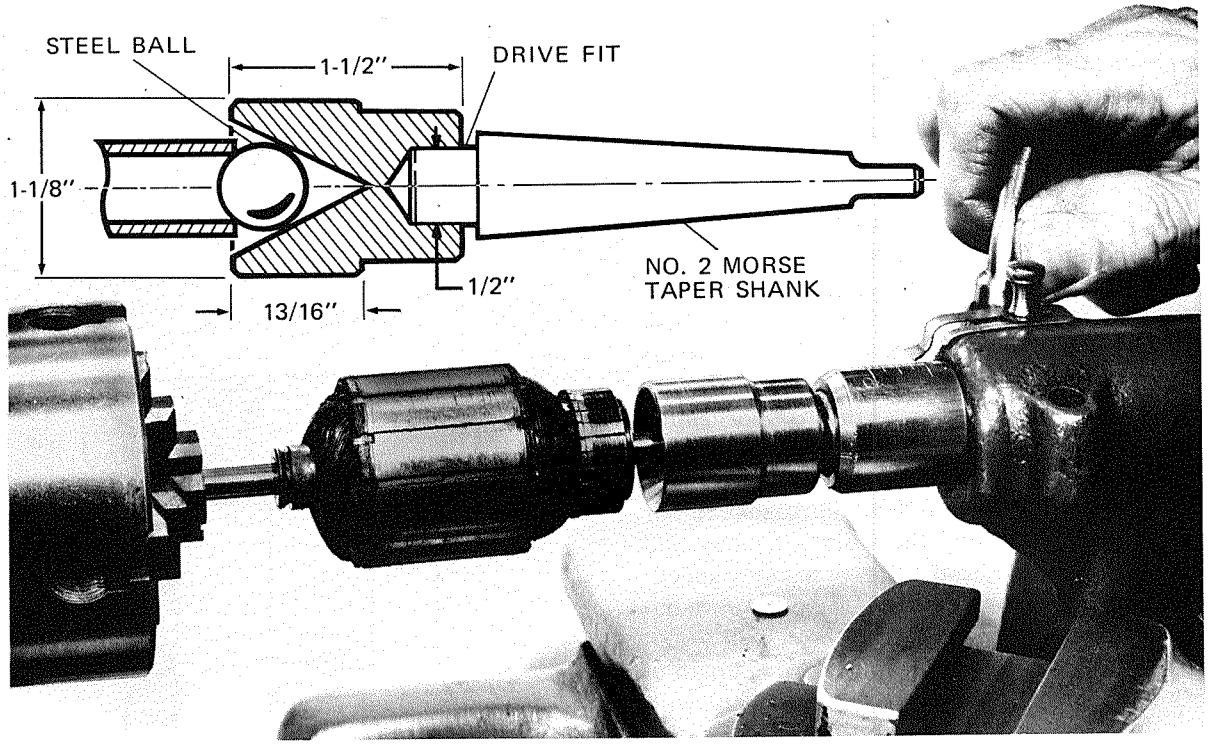


CUTTER BIT is locked in the holder by hollow-head setscrews turned with an Allen wrench.



Four practical lathe ideas

By WALTER E. BURTON



Hollow-cone lathe center

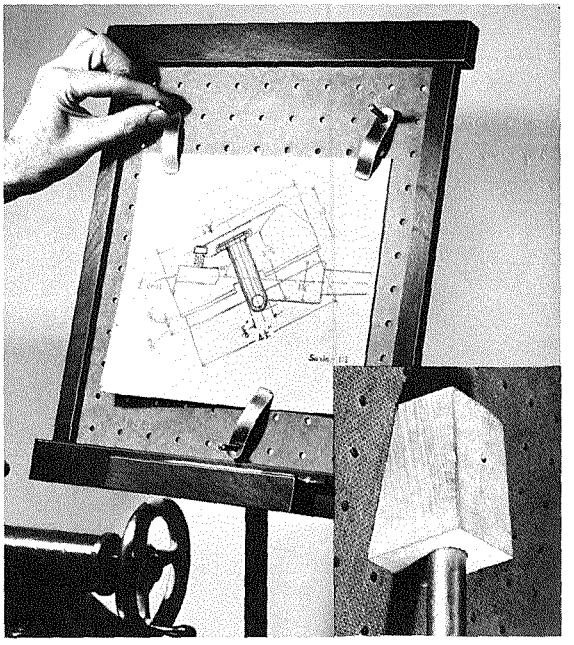
A hollow-cone lathe center is useful when a motor armature or other piece of work that has no center hole is to be mounted for turning, filing or polishing. The cone can also hold a steel bearing ball that serves as a center for tubing or other piece, especially one having an i.d. too large to rotate on a regular center.

Hollow centers other than cone-shaped can be used, but a cone will accommodate a range of diameters. A hollow center can be used in the tailstock, with a chuck grasping the other end of the workpiece; or both headstock and tailstock centers can be hollow, if you have a lathe dog to drive the work.

The cone center illustrated was made by machining a conical cup of approximately 1-in. maximum diameter and having an apex angle of slightly more than 60°, in a piece of 1⅛-in.-dia. steel rod fitted tightly over the end of a taper shank from a broken twist drill. The cone was machined with this assembly inserted into the headstock-spindle taper. Greater wear resistance would result if the cone surface were hardened, and finish-grinding is desirable after hardening, for greatest accuracy.

If a steel ball is used in the cone, it is selected to suit the internal diameter of the tubing or other piece to be centered. Ball diameter is somewhat greater than tubing i.d. Of course, whether the workpiece is positioned against the conical surface or the ball, its end must be square and even. Sometimes the end can be trued with the help of a center rest. Also, the part contacting the cone or ball must be kept lubricated.

SEE ALSO
Drill presses . . . Drill-press accessories . . . Drill-press techniques . . . Metal-lathe techniques . . . Threading . . . Tools, hand



Work-drawing holder

A piece of perforated hardboard is the heart of this handy lathe "bulletin board" on which drawings and other material can be displayed conveniently for the operator. The panel is mounted in any suitable frame.

A mounting block, cut from 2x4 stock with the face at about a 15° slant from the vertical, is fastened to the back of the panel at the center with four screws. A vertical hole is bored in the block so it will fit over the end of a length of ⅜-in. pipe fitted with a floor flange and fastened to the benchtop at the tailstock end of the lathe.

The holding clips shown were made from flat spring stock and fitted with knobs of 3/16-in. brass rod 1 in. long. Knurling the end knobs provides a better grip for moving them from hole to hole.

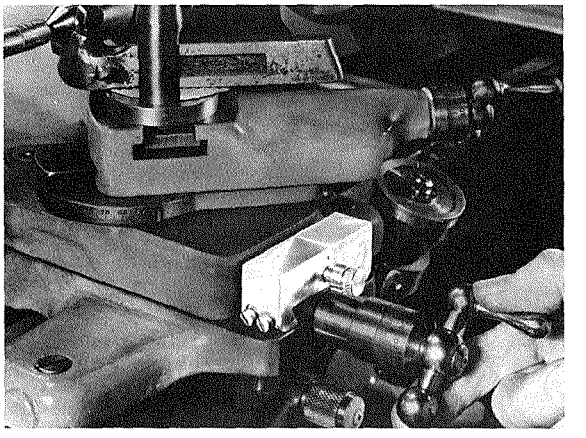
lathe ideas continued on next page

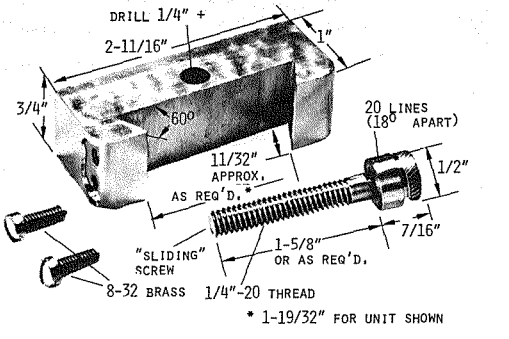
Cross-slide stop

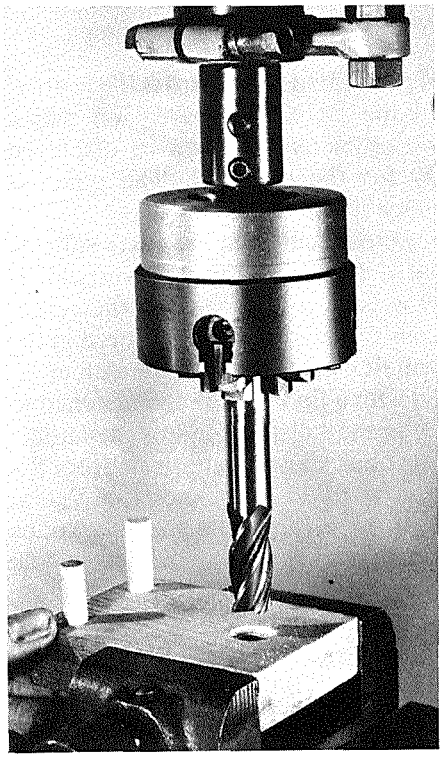
A cross-slide stop is an attachment that prevents a lathe cross slide from traveling beyond a predetermined point. Because it is particularly useful in threading operations, this gadget is sometimes called a "threading stop," but it can serve in other ways, too.

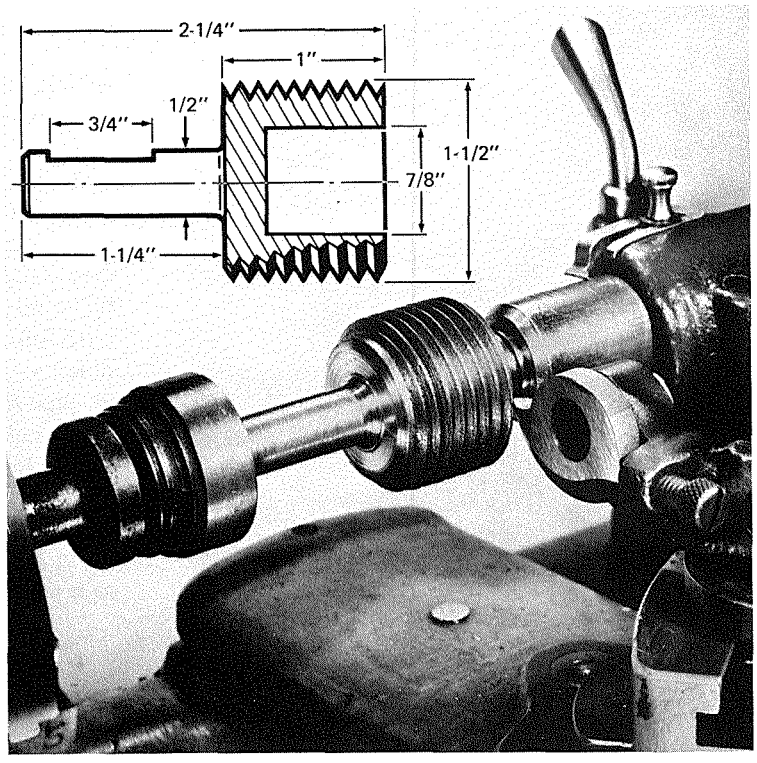
In thread-cutting, the stop enables the tool to be reset quickly to cutting position after it has been backed away from the work and returned to the starting point. For the new cut, the cross-fed screw is turned to move the slide toward the work, until the stop prevents any farther movement. This brings the tool to the work without running the risk of jamming or of your forgetting where the micrometer scale on the cross-feed screw has been set for the preceding cut. Chip depth is adjusted either by turning the "sliding screw" of the stop or moving the compound slide—and the new cut can be taken. In machining a number of parts to a certain diameter, the stop can be set to position the tool for the final cut—much as stops are used on turret lathes. Similarly, the stop can limit the depth of cut in forming slots, shoulders and the like.

Lacking a source from which to obtain a ready-made stop, you can whip together a workable one from a block of aluminum, case iron or steel, two small bolts for setscrews, and material (such as ½-in.-dia. rod) for a "sliding screw."









Lathe chuck on drill press

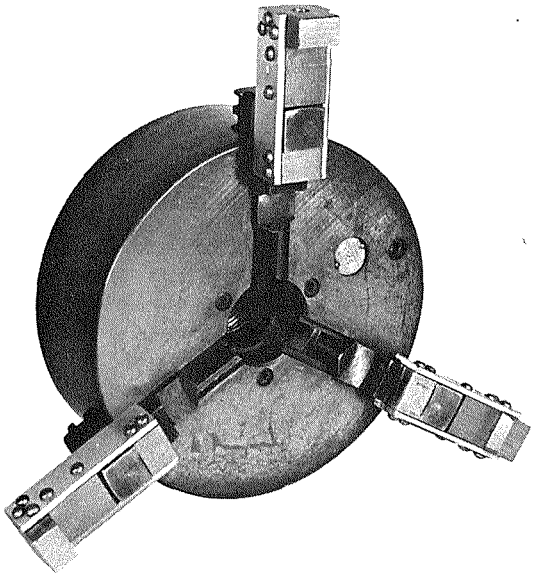
A small lathe chuck mounted on the spindle of a drill press that normally handles up to ½-in.-shank bits enables you to use a ⅝-in. straight-shank end mill for counterboring holes in hardwood to a diameter of nearly 1-in.

Such a chuck can expand drill-press use in other ways. If it is an independent-jaw type like the 3-in. Craftsman chuck shown, it can handle unsymmetrical or odd-shaped cutters of various kinds. For instance, a cutter could be made from flat steel stock to turn decorative rosettes on wood, and the chuck jaws adjusted to grip it firmly.

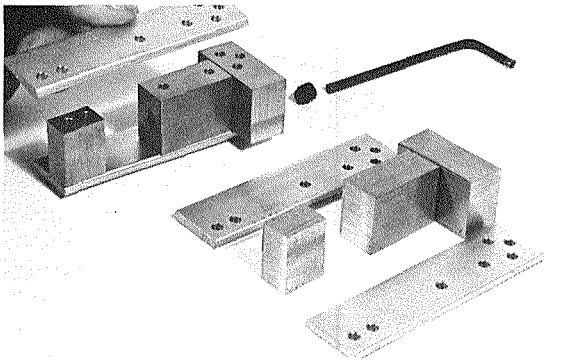
To counterbore a hole to almost 1-in. dia. with the ⅝-in. end mill shown, the tool was set off-center as far as the chuck opening permitted. The spindle was run at rather low speed, and feed was gradual and careful to prevent the tool from grabbing. A spindle with considerable play might have been a problem in this case.

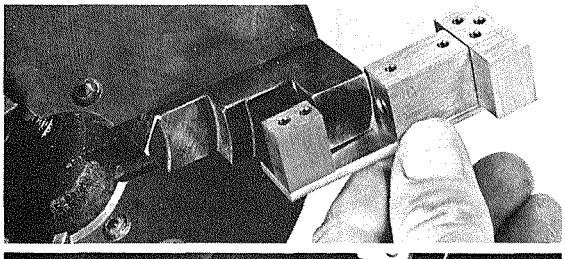
The adapter for connecting the chuck shown to a ½-in. pot (setscrew) chuck on a Delta drill press consists of a steel plug having a 1½-in.-8 thread about 1 in. long—the same thread as that on the headstock spindle of a lathe on which the chuck normally is used. Projecting from this plug is a ½ x 1¼-in. shank to fit in the pot chuck. It has a flat for two setscrews to bear against. The plug center was bored out to permit tool shanks to project farther into the chuck. Photo and drawing above show how adapter is made.

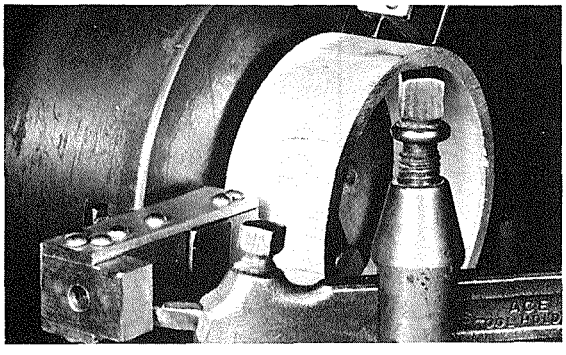
A chuck permitting a drill press to handle larger-than-normal bits and cutters should not give license for attempting to do work that will overstrain the machine. However, there are numerous little jobs such an arrangement can make possible. For example, an oversize drill bit can be expected to work satisfactorily in such "gentle" materials as wood without overloading the spindle or other parts—but it might not be advisable for drilling tough metal. Spindle speed should be regulated to match size of bit or cutter used.



BECAUSE CHUCK sizes vary so much, the stretcher dimensions must be made to suit the chuck being used. The parts are cut from bar and sheet stock, drilled for hammer-driven, type-U self-tapping screws. The photo second from the bottom shows how the stretcher fits the chuck jaw. At bottom, stretchers are clamped to the jaws and a light cut is taken on them to make them run true; jaws are held rigid with a large piece of round scrap (a short section of large-diameter pipe was used here). Matching numbers should be scribed on stretchers and jaws to assure correct replacement.







Give your lathe chuck a bigger bite

By PHILIP DUCLOS

Whether your lathe chuck is a three or four-jaw model you can use these stretchers to hold work that is as much as three and a half inches in diameter larger than your chuck

■ HERE'S A HANDY set of jaw stretchers for any lathe chuck. They will work on either a three or four-jaw chuck and let you handle large-diameter work. With them, my 6½-in. chuck now holds work up to 10 in. in diameter.

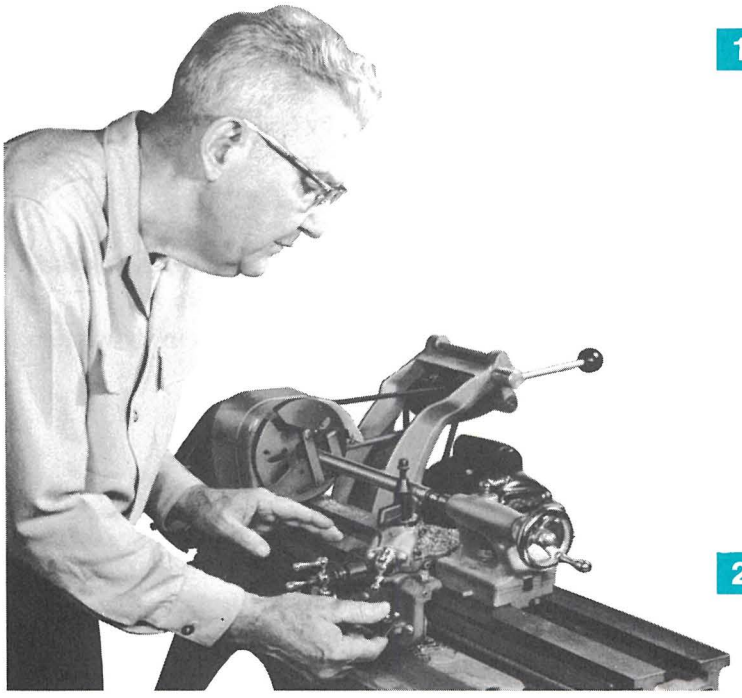
I used $^{5}/_{16}$-in. No. 6 type-U, hardened drive screws to pin the stretcher parts together. These drive screws are easier to use than ordinary machine screws—because they require no tapping and are installed with a hammer—but if you cannot obtain them in local stores, you will have to tap (thread) each hole for a bolt or machine screw.

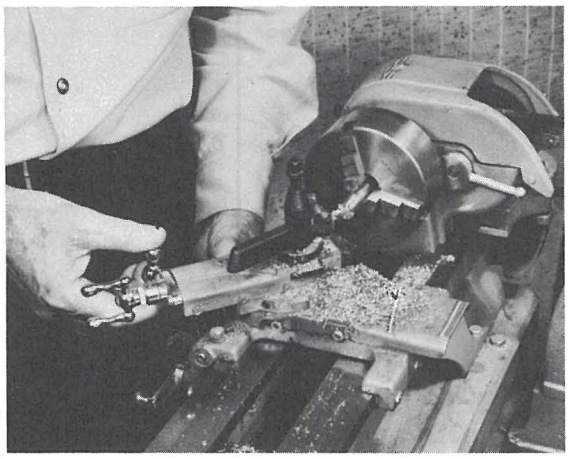
The stretchers are clamped to the chuck jaws with ¼-20 Allen setscrews. As the setscrew holes are deep (nearly equal to the distance the extensions give), it is advisable to counterdrill with a tap-clearance drill to about three-fourths the depth of each hole—otherwise, it may be too deep for a standard tap.

SEE ALSO
Metal-lathe techniques . . . Tools, hand

A short course in metal turning

By W. CLYDE LAMMEY





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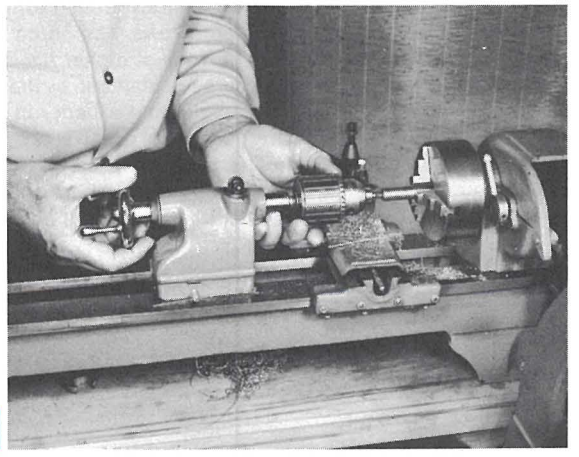

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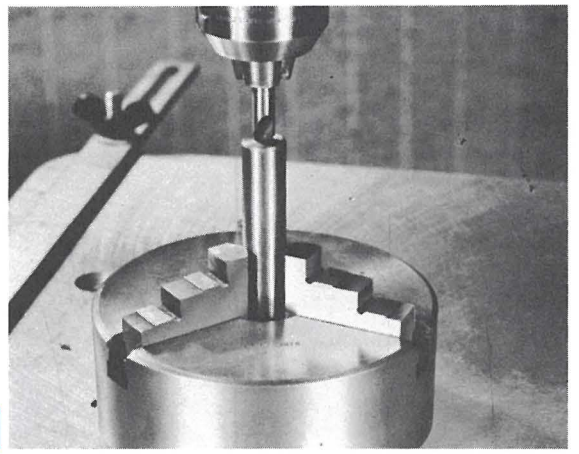


3

METAL TURNING can be as fascinating as wood turning, and while it requires using a whole new set of rules, learning to operate a metal lathe is really pretty simple when you get right down to basics.

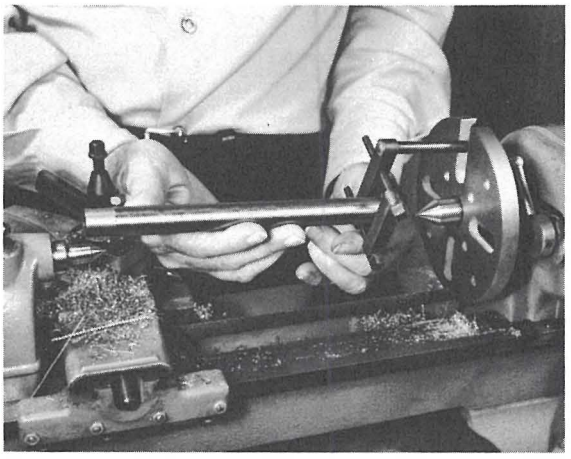
Learning how to set up work for turning between centers and on a faceplate is lesson number one.

The first step is to rough-cut the workpiece to length with an allowance for facing both ends, when facing is required. For practical purposes this can be done with a hacksaw, using care to cut the ends square. Or, if the nature of the work and the material available permit, cut the workpiece over-length so that you can machine it to finish diameter and length up to the driving dog and then cut off and face the end. When measuring the length, be sure to allow for the dog.

The next step is centering. If the work will pass through the hollow, headstock spindle, then

SEE ALSO

Machining . . . Metal-lathe accessories . . . Threading . . . Tools, hand



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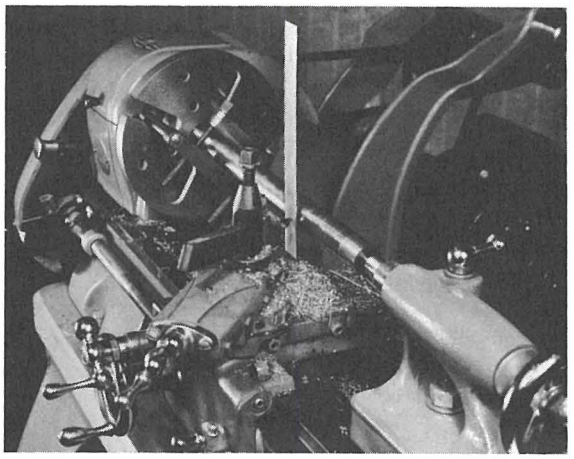

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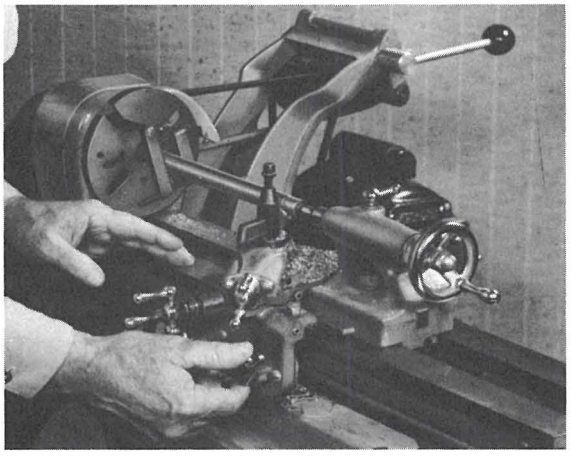

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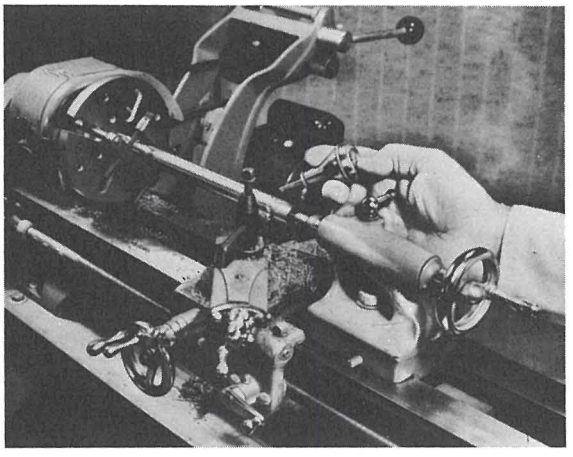

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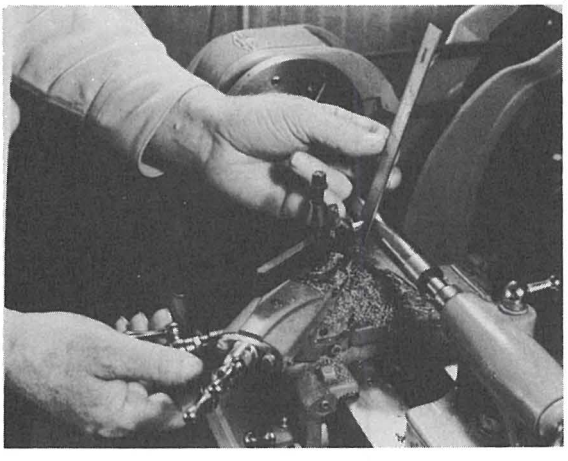

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chuck it in the lathe's three-jaw chuck, letting it project a minimum amount. Now face off and center-drill the ends with a combination center drill and countersink as pictured and detailed in Figs. 2, 3 and 10.

If the workpiece is too large to pass through

1. THE FIRST STEP in mounting between centers is facing the ends of the workpiece square. Indent the center so the center drill will start accurately.

2. WHEN WORKPIECE will pass through the lathe spindle, center-drilling is done in the lathe. Chuck the work and feed the center drill slowly.

3. IF THE WORK is too large for the lathe spindle, chuck it and center-drill in a drill press. Center-punch the work first and feed slowly.

4. AFTER CENTER-DRILLING, attach a driving dog and mount on centers. Make sure tail of the dog clears and the work turns freely without play.

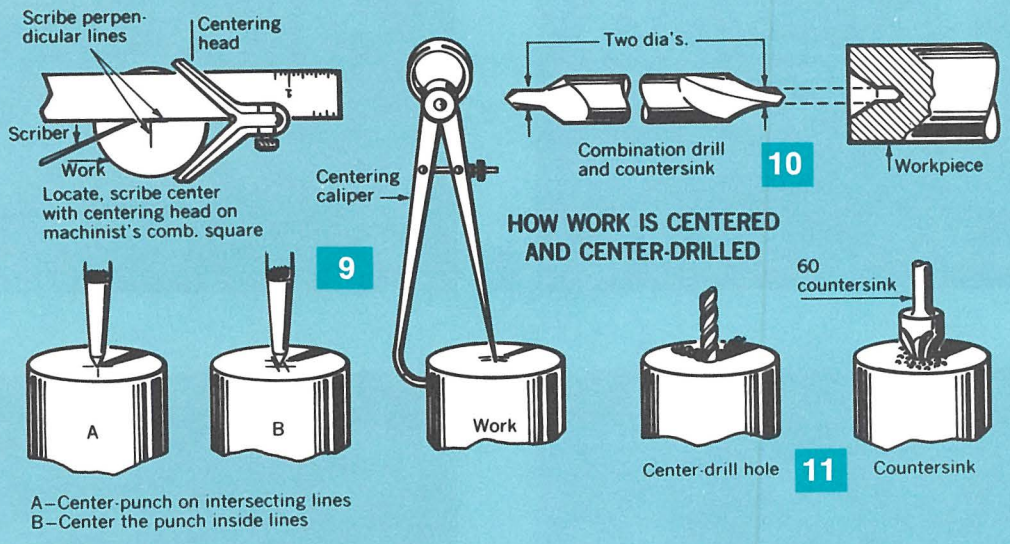
5. WHEN TURNING between centers, use screw or automatic carriage feed to get smoother work, and to prevent gouging and overloading of the bit.

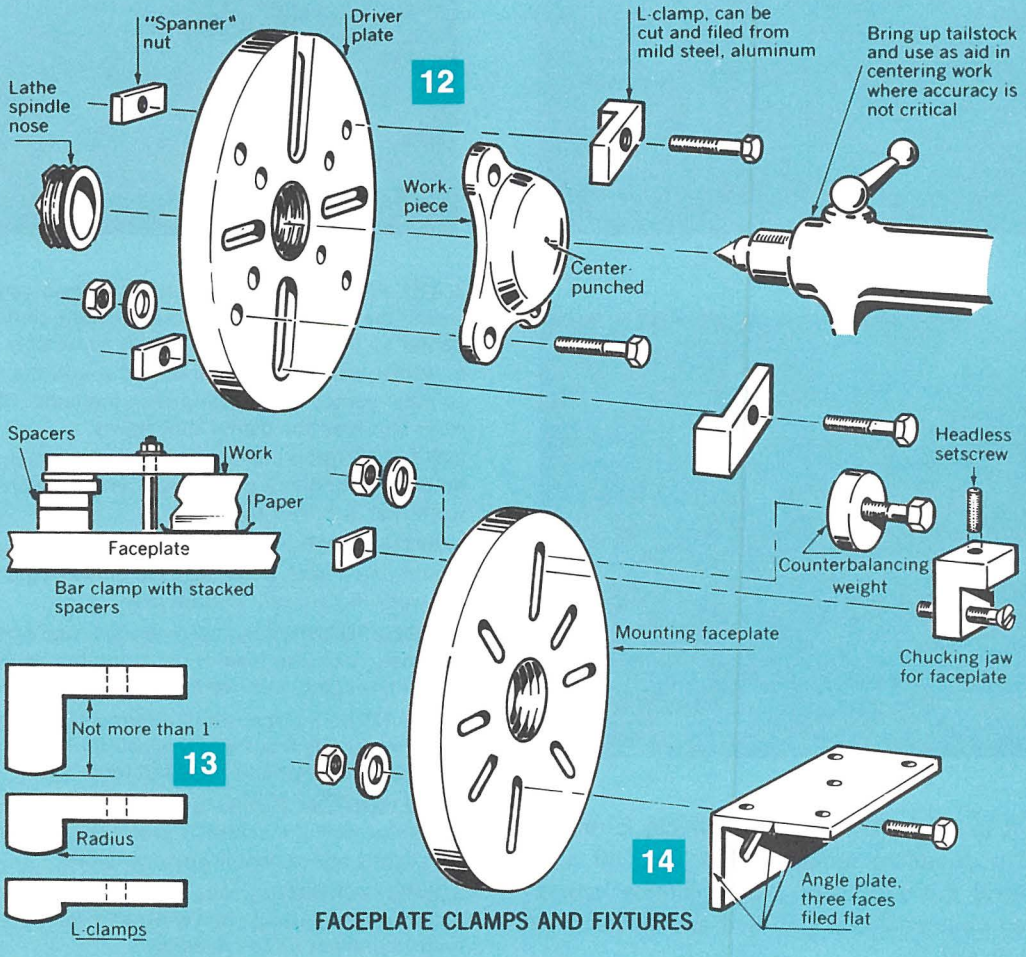
6. USE A RULE to locate the cutting tool on the axis of the lathe. Here, rule tilts away, indicating the point set too high. Recheck and reset the tool.

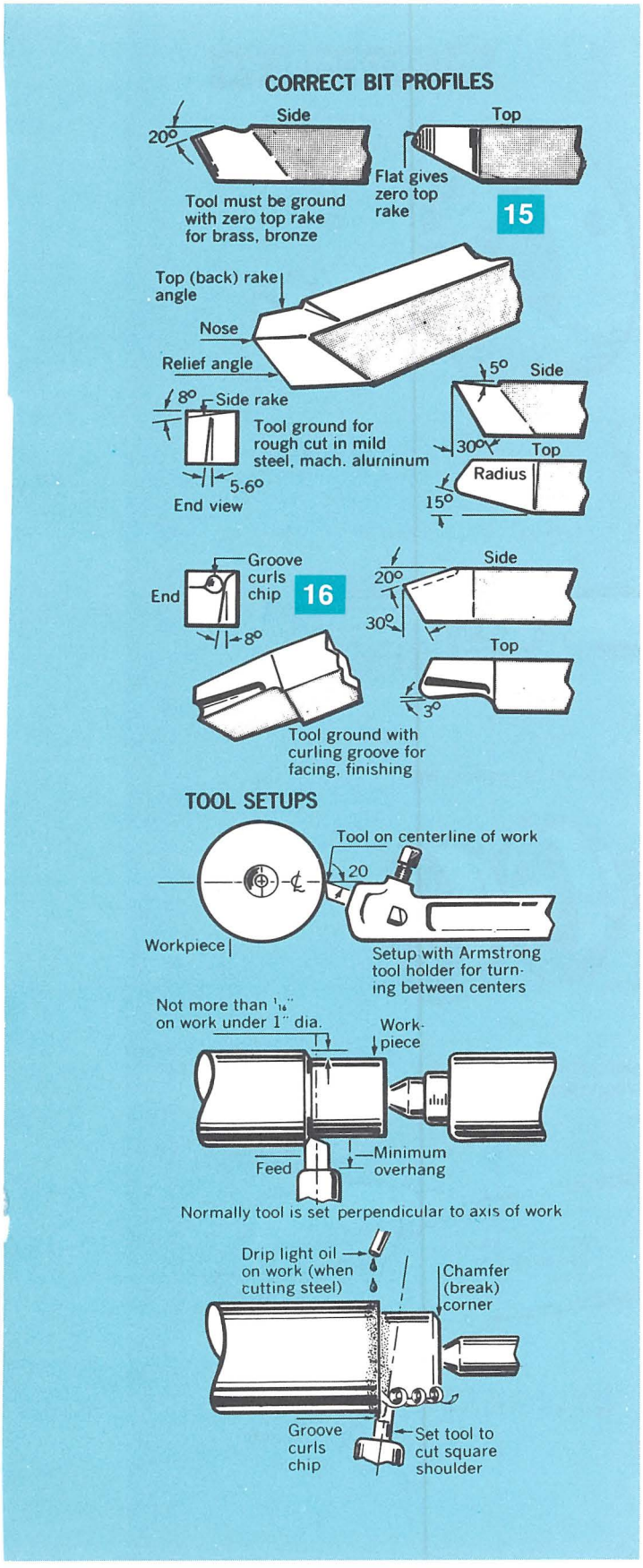
7. THE VERTICAL RULE indicates that the tool is set dead on center. Some machinists prefer the cutting tool set slightly above center on some work.

8. WHEN TURNING ferrous metals, an occasional drop of light oil at the cutting point will give a smoother cut and help to prevent undue heating.

HOW TO GET STARTED IN METAL TURNING







the spindle but will drop through the hole in your drill-press table, locate and scribe the centers, using either a centering head on a machinist's combination square or a centering (hermaphrodite) caliper as detailed (Fig. 9.) Then, using the lathe chuck, hold the workpiece and drill the center with the combination drill and countersink in the drill press as pictured in Fig. 3.

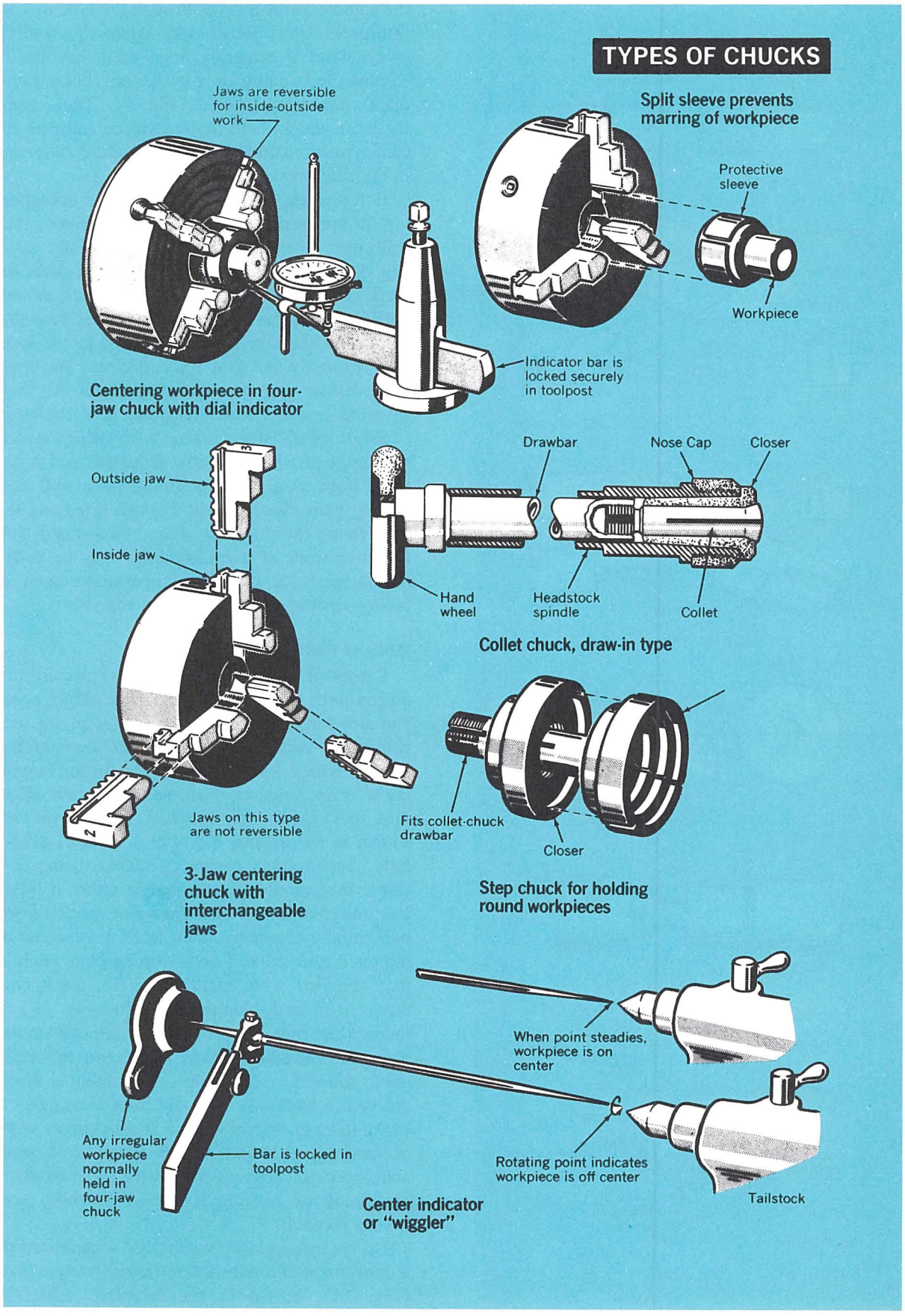
If too large in diameter for either operation, lay off and scribe the centers as described, then drill and countersink in two operations as in Fig. 11. The facing cuts can be taken after the work is mounted between centers. When mounting the workpiece between centers, be sure that the tail of the dog engages the slot in the faceplate properly and that the end clears the headstock before you start the lathe. Turn the work by hand to make sure everything is in the clear.

Small metal lathes, under 9-in. swing, usually are supplied with one large faceplate which can serve both as a work mounting plate and as a driving plate. Such a plate has one open-end slot for driving the dog and several closed-end slots to which work of irregular shape may be bolted or clamped for machining operations such as facing, drilling and boring. See Fig. 12.

types of plates

Lathes of 9-in. swing and up are usually furnished with a small plate having a single open-end slot for driving the dog. Larger plates with closed-end slots and spaced holes are supplied as accessories. Such plates are useful for mounting a wide range of workpieces of such shape that they cannot be chucked. Both types are shown in the details, Fig. 12. A typical, irregularly shaped small casting is shown, being of a shape that cannot be chucked in either a three-jaw universal chuck or a four-jaw chuck having individually adjustable jaws. Such a piece can be mounted and worked on a driving plate such as that supplied with small lathes by using two, three, or more L-clamps and bolts (Fig. 13), if the work permits, as fastenings. Although similar clamps are available ready-made, you can make them yourself, using mild steel which is easily cut with a hacksaw, filed and ground as needed. Make them in several sizes to accommodate work of varying proportions and thicknesses. If desirable, you can improvise a chuck for noncritical machining by making L-shaped chucking jaws for the faceplate.

On large faceplates, machinists sometimes find it convenient to mount the work on an angle plate (Fig. 14), bolted to the faceplate. Like the


TYPES OF CHUCKS
Jaws are reversible for inside-outside work
Indicator bar is locked securely in toolpost
Centering workpiece in four-jaw chuck with dial indicator
Split sleeve prevents marring of workpiece
Protective sleeve
Workpiece
Outside jaw
Inside jaw
Jaws on this type are not reversible
3-Jaw centering chuck with interchangeable jaws
Drawbar
Nose Cap
Closer
Hand wheel
Headstock spindle
Collet
Collet chuck, draw-in type
Fits collet-chuck drawbar
Closer
Step chuck for holding round workpieces
When point steadies, workpiece is on center
Any irregular workpiece normally held in four-jaw chuck
Bar is locked in toolpost
Rotating point indicates workpiece is off center
Tailstock
Center indicator or "wiggler"

L-clamps, angle plates are available ready-made, but you can make one suitable for noncritical work from a short length of ordinary steel angle. This should be filed or ground, or both, on three faces as indicated, with special care taken to maintain the outside angle at 90 deg. and all surfaces flat.

When you're mounting work on an angle plate —or, in some instances, clamping work to the faceplate—it is necessary to provide a counterbalancing weight. These are easily made from round steel stock by cutting and machining disks of varying diameters and thicknesses and center-drilling to take a small bolt for attachment. After mounting the counterbalance, make short test runs to make sure the setup is in close balance.

Correct grinding, honing and mounting the tool in the toolholder and on the toolpost come next. To cut properly in ferrous metals, such as ordinary steels and certain machining aluminums, the tool should be ground with a top (back) rake, side rake and relief angle as detailed (Fig. 15). The angles given are used in general practice, but some machinists vary these slightly for certain purposes.

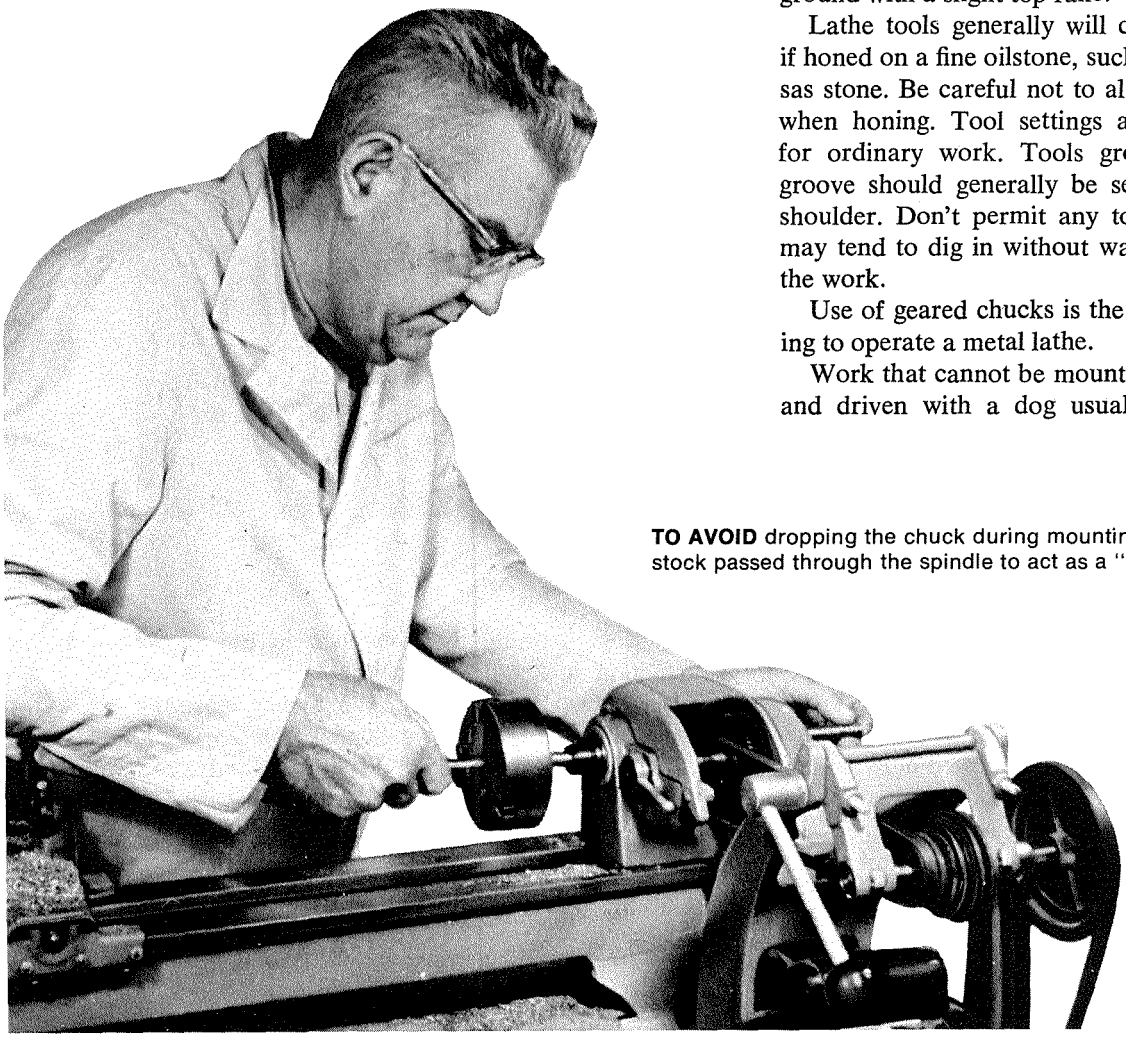
For common nonferrous metals, such as brass and bronze, the cutting tool should generally be ground with a negative, or zero, top rake and little, if any, side rake. In all cases, except for threading, the nose should be ground with a very slight radius. Use a medium-fine grinding wheel (preferably a vitreous wheel) and be careful not to overheat the cutting edge. Carbide-tipped tools must be ground on a specially made wheel.

For finishing cuts, tools may be ground with a round-bottom chip groove as detailed (Fig. 16). Properly ground (this is, of course, rather difficult on tools less than ¼-in. square), such a tool leaves a smooth finish, as it curls away a continuous chip, generates somewhat less heat when cutting and requires less power. Although shown with negative top rake, some machinists prefer it ground with a slight top rake.

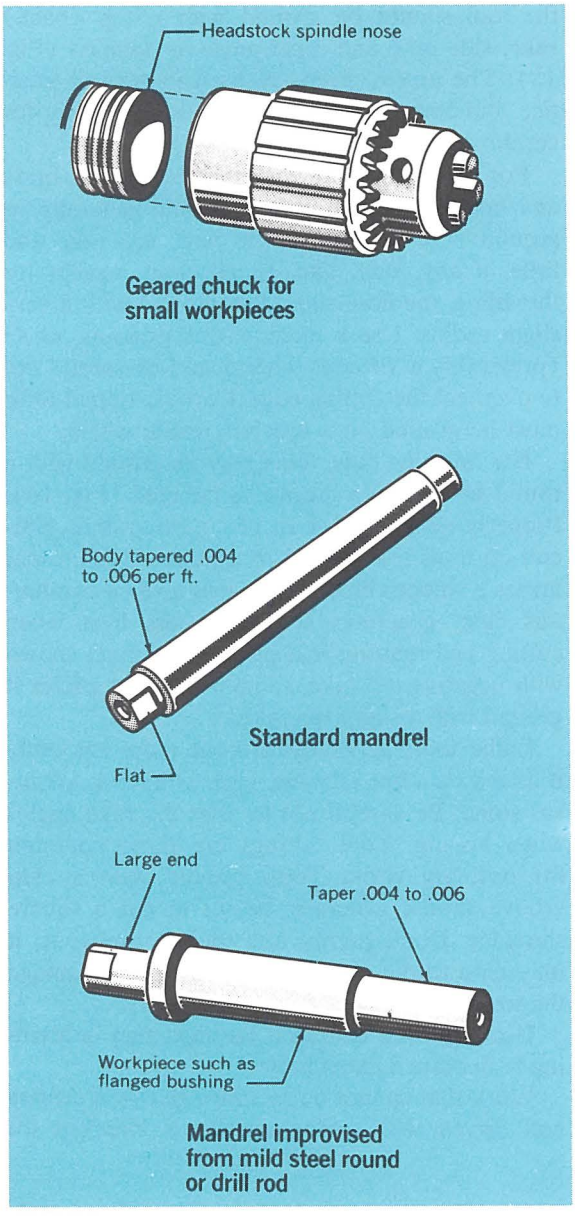
Lathe tools generally will cut more smoothly if honed on a fine oilstone, such as a hard Arkansas stone. Be careful not to alter the rake angles when honing. Tool settings are those common for ordinary work. Tools ground with a chip groove should generally be set to cut a square shoulder. Don't permit any tool to undercut; it may tend to dig in without warning and damage the work.

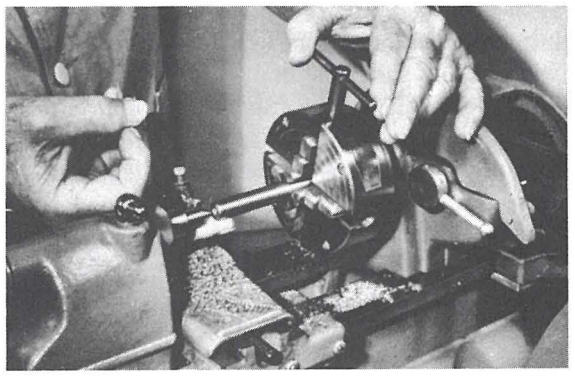
Use of geared chucks is the next step in learning to operate a metal lathe.

Work that cannot be mounted between centers and driven with a dog usually is chucked for



TO AVOID dropping the chuck during mounting, clamp it on round stock passed through the spindle to act as a "handle."


Headstock spindle nose
Geared chuck for small workpieces
Body tapered .004 to .006 per ft.
Flat
Standard mandrel
Large end
Taper .004 to .006
Workpiece such as flanged bushing
Mandrel improvised from mild steel round or drill rod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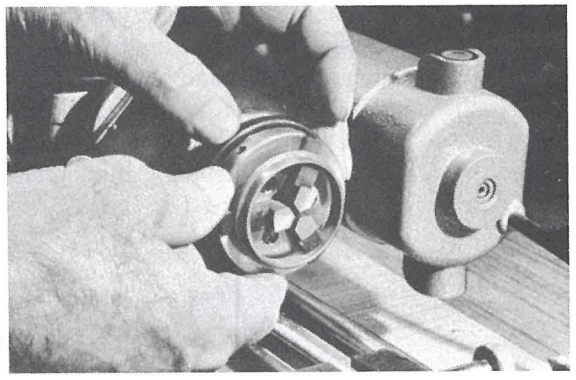
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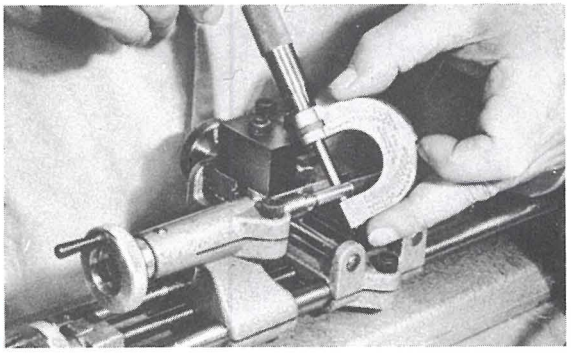
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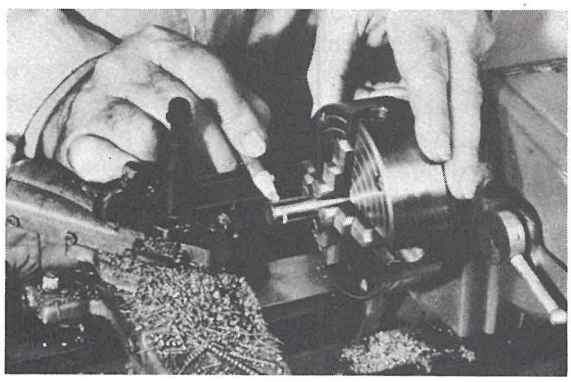
metal-turning short course, continued

machining. Chucks for everyday work are of several types, all operated manually with a special wrench.

Perhaps the most common is the four-jaw chuck on which each jaw is operated individually. These usually come with a set of jaws that can be reversed to hold inside or outside work ("inside" and "outside" refer to the way in which the jaws engage the workpiece). Concentric rings, equally spaced, are machined on the face of the chuck to help center the work.

Next in common usage is the universal, or scroll, chuck on which the three jaws are self-centering. Turning the T-wrench in the single actuating socket on the chuck body moves all three jaws simultaneously. When they close on the workpiece it is automatically centered. Such chucks are accurate within .003 or less and come with two sets of jaws—for inside and outside work. Some miniature scroll chucks have one reversible set.

In addition to these two common types there are spring collet and step chucks; both are actuated by a spindle drawbar and also a geared chuck (similar to a drill chuck) that turns onto the spindle nose and is ordinarily used for "live"



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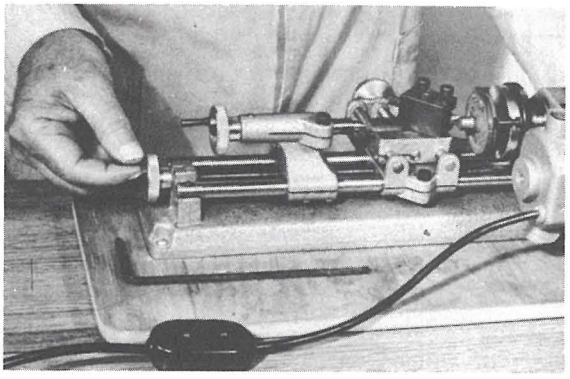

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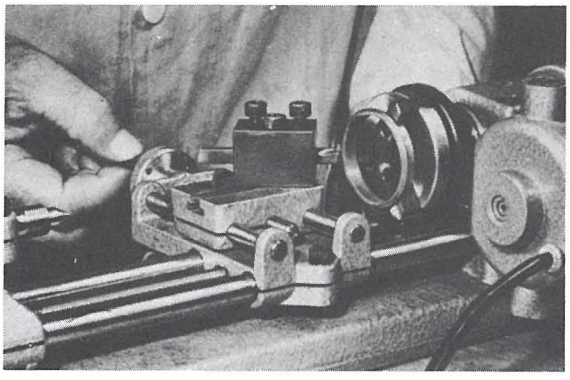

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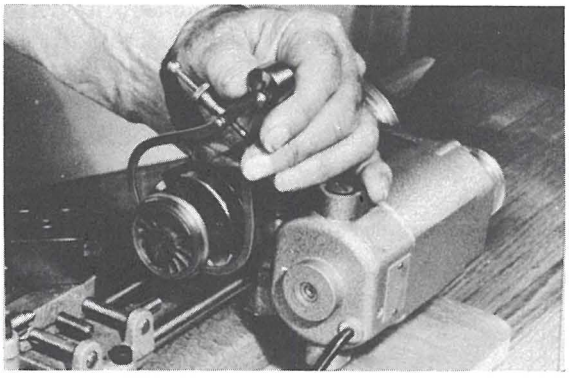

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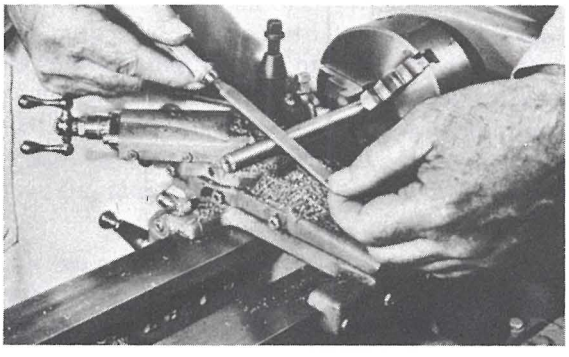

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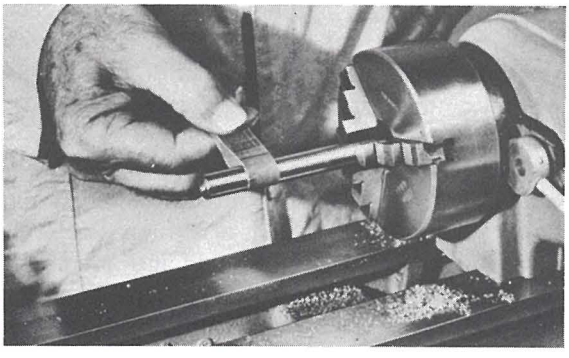

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1. The tailstock center is used as an indicator for centering in a four-jaw chuck. The workpiece is center-punched or center-drilled. Not for close work

2. Grip the inside of the workpiece with jaws of a universal chuck by backing them out rather than running in, to permit both edging and facing of work

3. When you must come close, use a mike, especially on small-diameter work where it is more difficult to "feel" a caliper. Be sure of the reading

4. This shows the chalk or pencil-mark method of centering in a four-jaw chuck. Here the line is not continuous, showing that the work is off center

5. Grip the outside of the workpiece for a final backfacing operation by reversing the jaws. On most universal chucks, the jaws should be interchanged

6. Make a mandrel for average work when you don't have a ready-made one handy by filing a taper on the round of a drill rod that has been center-drilled

7. Here is the machining of a chucking lug on model-locomotive drive wheel. The work is held in the outside of three-jaw chuck with reversible jaws

8. On ordinary work not requiring close tolerances, diameters can be checked quite accurately with calipers. Finger sensitivity largely determines accuracy

9. Finish the taper by smoothing with a loop of fine abrasive cloth, checking the diameter frequently until you have the correct taper of .004 to .006

drilling operations, with the work supported by a pad held in the tailstock.

The collet chuck also is widely used in the machining of small parts requiring close tolerances. Spring collets range from about ⅛ in. up, the sizes usually increasing by 16ths.

The step chuck is really a collet-chuck accessory. It is threaded to fit the collet-chuck drawbar and each unit is designed to hold two or more sizes of rounds, such as disks or small gear blanks, for machining. Both collet and step chucks are especially useful for repetitive work; the workpiece can be locked quickly in place in the collet, where it is automatically centered, then machined and released by a short turn of the handwheel. Modelmakers, experimenters and metal-working hobbyists find these chucks useful for machining small parts.

rough-center the workpiece

When working with the independent four-jaw chuck, you rough-center the workpiece, with the concentric rings on the face of the chuck aiding in placement. For ordinary work not requiring close tolerances you can use the tailstock center as an indicator when the workpiece has been center-drilled or center-punched. The usual procedure is to set two adjacent jaws and then work the third and finally the fourth to bring the workpiece to dead center. With care, this can be done quite accurately.

Another fairly accurate method is to rough-center the work and then hold a piece of colored chalk or a china-marking pencil on the toolholder. The pencil point should just touch the high point of the workpiece when the lathe spindle is rotated by hand. Move jaws slightly until the pencil scribes a continuous line.

When a machining job requires working within close limits, you must use more accurate centering methods. A center indicator, or "wiggler," gives good results when set up as shown on page 1962. Center-punch the workpiece, rough-center it, and move the chuck jaws slightly until the indicator arm steadies as the work is rotated and you have it very close.

The dial indicator is more sensitive and faster, and it can be used on a greater range of work shapes. The workpiece need not be center-punched, since the actuating arm of the instrument can be located to ride on any smooth surface, inside or outside or on the face when it is necessary to test for out-of-true axially or radially. When the needle steadies you are quite sure the work is dead-centered.

A note of caution: Use a protective sleeve when chucking or rechucking workpieces that are fragile or partially machined. To protect the machined surface from the chuck jaws, cut a short sleeve from tubing with an inside diameter that will slip-fit the workpiece (or machine a sleeve to fit). Slot it as shown at the top of page 1962 and slip on the part of the workpiece to be gripped in the chuck. The sleeve protects from marring and gives support to fragile work that might be crushed out of round in the chuck. Avoid overtightening the jaws, or both chuck and work may be damaged.

All-over machining sometimes presents a problem in holding the workpiece, such as a bushing. The first step is to bore, ream and face to specifications, with the bushing held in the chuck. Then remove the bushing and mount it on a mandrel that will take the bore of the bushing in a close press fit.

Ready-made mandrels come in many sizes, usually tapered from .004 to .006 per ft. For work not requiring extreme precision, you can make a mandrel as shown in the two bottom photos on page 1965, tapering it to take the bushing. The latter should be a fairly tight press fit after the mandrel has cooled to normal temperature. Of course, the mandrel must be center-drilled and a flat filed or ground at the big end to assure that the driving dog does not slip when the work is mounted between centers for final all-over machining.

The many extra jobs your metal lathe can do, in addition to all the standard metal-turning operations are taken up in this part of our story. Even the small machines can be set up to do such work as drilling, reaming, milling, thread-cutting, knurling and turning tapers. And, you can turn the harder woods by replacing the 60-deg. centers with the spur and cup centers and substituting a short metal bar for the toolholder. You just swing the toolpost so that the bar is parallel with the workpiece.

Drilling is perhaps the most common "side" operation done on a metal lathe. On a small lathe you can use drill bits from needle size to ½ in. or more as the tailstock, fitted with a precision drill chuck, gives an extremely sensitive feed.

When drilling the larger diameters, it's advisable to run in a pilot hole first, using a small-diameter bit that you are sure is perfectly straight

and correctly ground. The hole will serve as a guide for the larger bit. Ordinarily the pilot hole should not be more than one fourth the diameter of the larger hole—sometimes, less is preferable. Before drilling either hole, make sure the tailstock quill (or sleeve) taper is clean, with no chips or grime. Also wipe the tapered drill shank and place a drop of very light oil on it before inserting it.

You won't need a lubricant to drill most nonferrous metals and cast iron, but when drilling steel an occasional drop of light oil will result in a smoother job and prevent undue heating. When the finish hole is to be of large diameter, it's often best to drill undersize and then finish to the required diameter with a boring tool.

reaming to final size

Work specs frequently call for reaming to final size. In any case, if you are working to close limits it's well to follow through with this step. Drill the hole slightly undersize—about 1/64 in. in the larger sizes—then go through with a straight reamer of the final diameter desired. This will give you a smooth, true hole of exact diameter as long as you don't remove the work from the chuck between the two operations.

Accurate screw threads can be cut on a lathe equipped with a lead screw. The cutting tool must be ground with a 60-deg. point and the compound turned 29 deg. to the right for cutting the common external threads. The tool must be set at right angles to the axis of the workpiece. If you have a center gauge, use it to obtain an accurate setting as detailed in the third sketch on page 1970. Also, the cutting tool must be set exactly on the center line, or axis, of the workpiece to produce the best work. Somewhere on your lathe—usually on the inside of the gear cover or on the quick-change gearbox—you'll see an index chart listing the correct change gears to use in the train to cut a given number of threads per inch.

Diagrams on the change-gear lathe will show position of the change gears for cutting any thread within the lathe's capacity. With the gear train arranged to cut the thread desired, center-drill the workpiece and mount it between centers. Drive with a dog as in the left center threading photo on page 1969. Usually it is desirable, when the lathe carriage has no threading stop, to run in a shallow groove with a cut-off tool at the finish end of the thread to get clearance to back off the threading tool at the end of the cut.

On the simple threading dial you'll see four (some have eight) equally spaced marks. All pass a single witness mark as the dial slowly rotates. To start any even-numbered thread, such as 12 or 24 per inch, with the lathe running, engage the half nuts just as the rotating zero mark coincides with the witness mark.

After the first scoring cut, back off the tool, disengage the half nuts, return the carriage to the starting point by hand and re-engage the half nuts at the *same* mark used previously on the rotating dial.

Normally the common threads—even finer ones—should be cut in several passes, feeding the tool in from 1/64 to 1/32 in. at each pass, the depth depending on the thread size.

Cutting an internal thread requires much the same procedure as does the external thread, except that the feed is toward you, and you use a different type of threading tool. Also, there must be clearance in the bore for backing off the tool, and the compound is set 29 deg. to the *left* instead of the right.

Milling, tapping, knurling, taper turning and cutting off are less frequently encountered, yet all can be done on a metal-turning lathe with available accessories. The main problem in hand tapping is getting the tap started accurately. The lower left photo on page 1969 shows how; you use the lathe as a support for the work and tap wrench.

knurling and taper turning

A considerable range of accurate milling operations can be done with accessories shown in the photos and sketches. Knurling, which provides that neat gripping surface on small screws and other hand-turned parts, is done with the special tool sketched, page 1970. To knurl any small part, you first turn it to diameter, chuck it (or mount it between centers), set the knurling tool on center in the toolpost and run up to the work. Apply enough pressure to score the work surface and make the first pass, using the leadscrew feed. Then, just before the knurling "wheels" clear the work surface, reverse the lead screw, turn up the cross-feed screw slightly to apply more pressure and allow knurls to feed back in a reverse pass. Continue until the knurl is cut in to the desired depth.

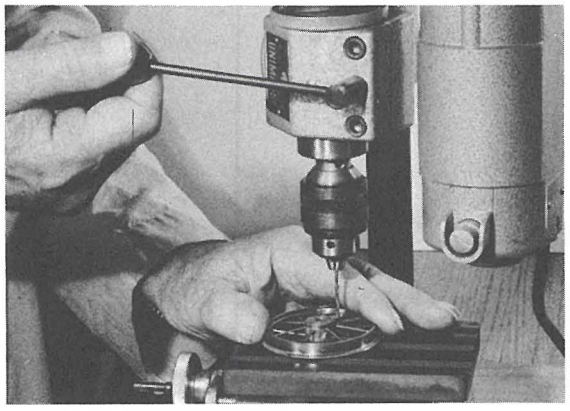
On small lathes without a taper-turning attachment, tapers may be formed by setting over the tailstock. A machinist's handbook (check your library) will give formulas for taper per foot to any degree.

Long workpieces to be turned to small dia-

metal-turning short course, continued

meters between centers tend to spring away from the cutting tool. To prevent this you'll need a follower rest, one type of which is sketched on page 1970. The cutting-off tool is useful mainly when a number of pieces are to be duplicated. It must be set exactly at right angles to the work-piece and precisely on center. Don't try this on work supported at both ends.

You'll get a great deal of satisfaction from



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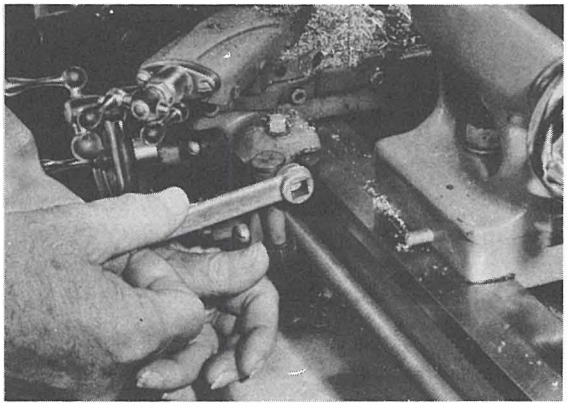
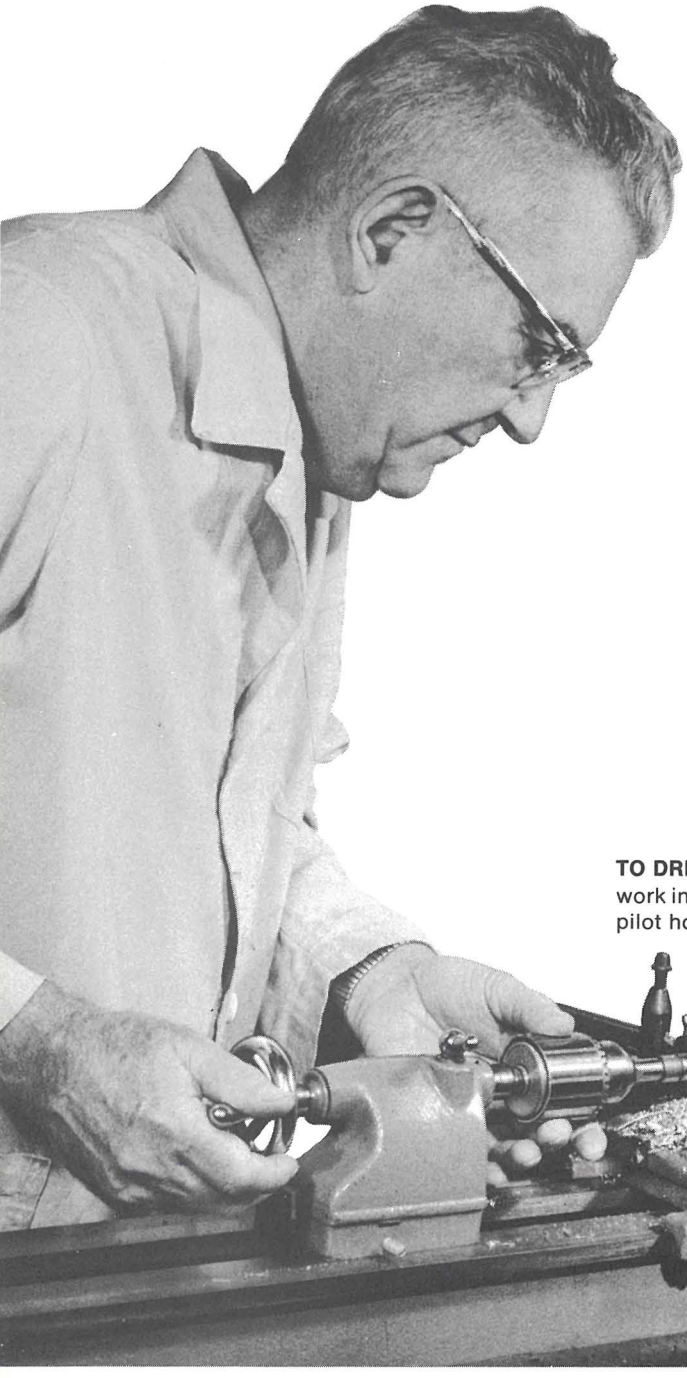


2

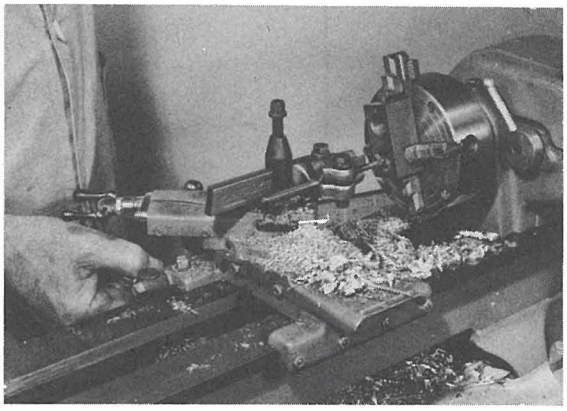
1. SENSITIVE DRILLING can be done on a small lathe with the headstock clamped to the vertical column that is an accessory with some makes.

2. THE FIRST STEP in thread cutting: Engage the dial with the lead screw. The dial saves returning the carriage with the lead screw on each pass.



TO DRILL WITH a ⅝-in. twist drill in a small lathe, grip work in a three-jawed universal chuck. A small-diameter pilot hole serves as guide for the larger bit.

3



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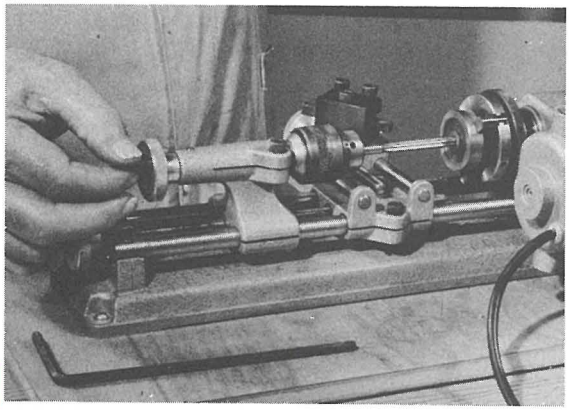

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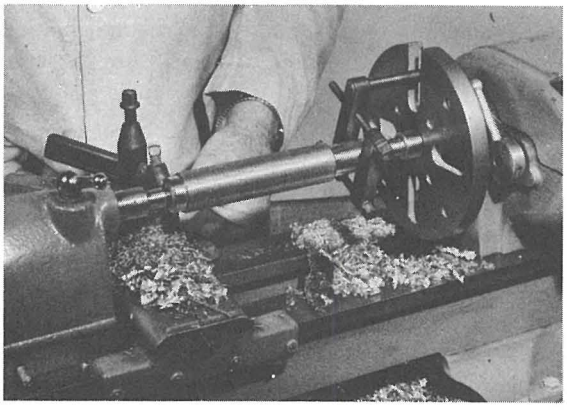

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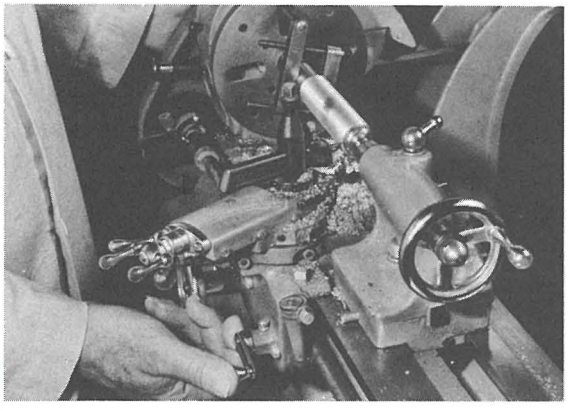

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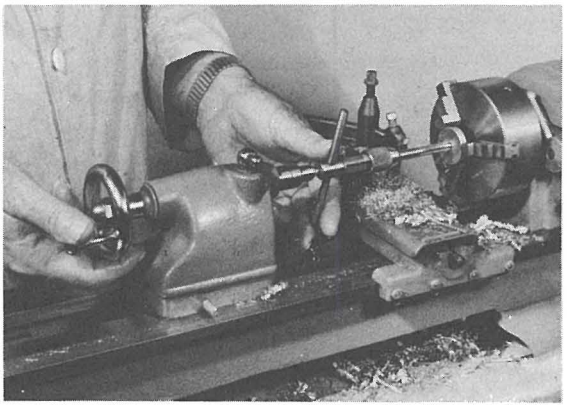

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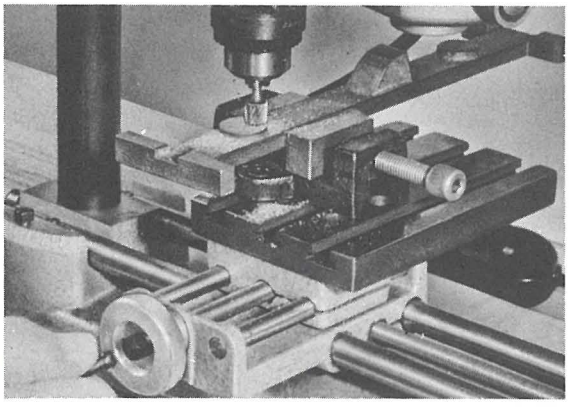


3. FINISH BORING of an off-center job shows that it is often best to drill large-sized holes undersized, then finish to the diameter with a boring tool.

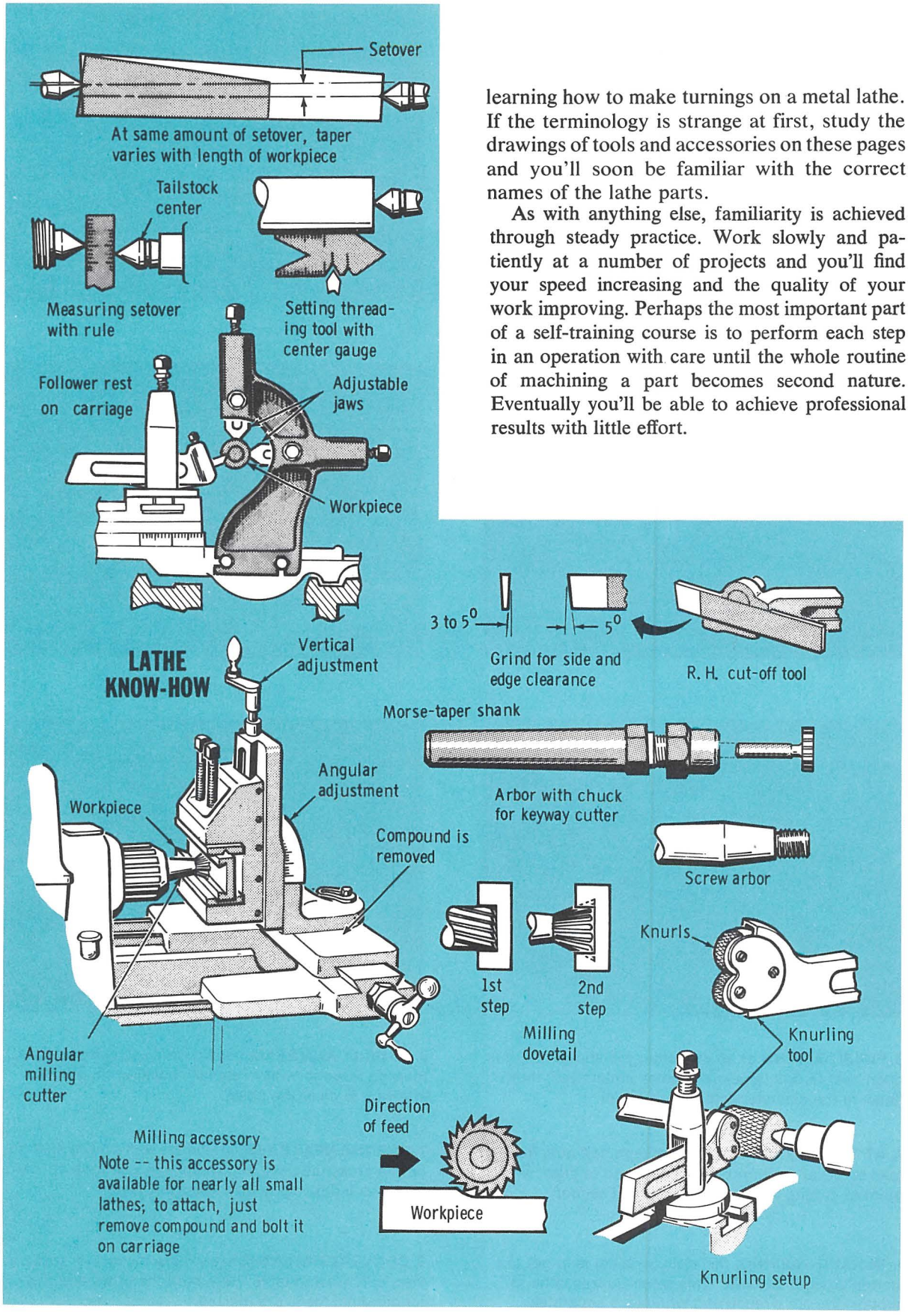
4. AT THE END of the pass disengage half nuts from lead screw and return carriage by hand to start, with point of cutting tool clearing threaded section.

5. IN HAND TAPPING, the main problem is to get tap started straight and true. This setup utilizes lathe to support the tap wrench and workpiece accurately.

6. TO DRILL AND REAM, you first drill an undersize hole, then go through with a reamer—backing off a bit at intervals to clear the chips.

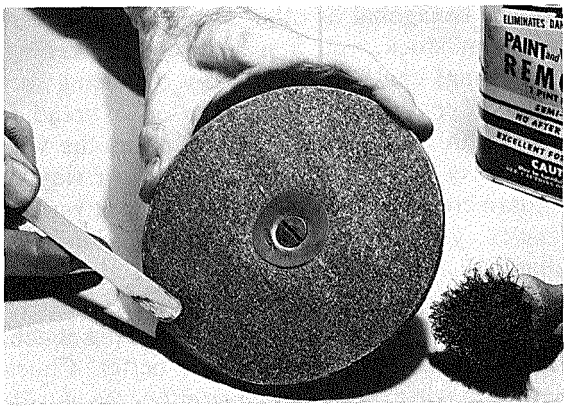
7. FOR THE NEXT PASS, in-feed the tool a given amount on the cross-feed dial and re-engage half nuts on lead screw as index marks on thread dial match.

8. CONVERT THE LATHE to a vertical mill with accessory vise, column and table. Here both the cross and the longitudinal feeds are utilized.

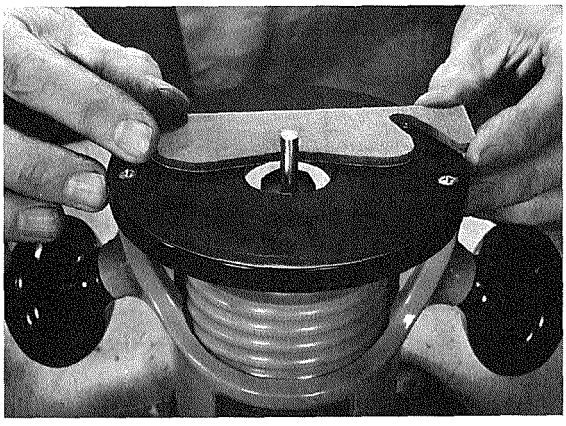


learning how to make turnings on a metal lathe. If the terminology is strange at first, study the drawings of tools and accessories on these pages and you'll soon be familiar with the correct names of the lathe parts.

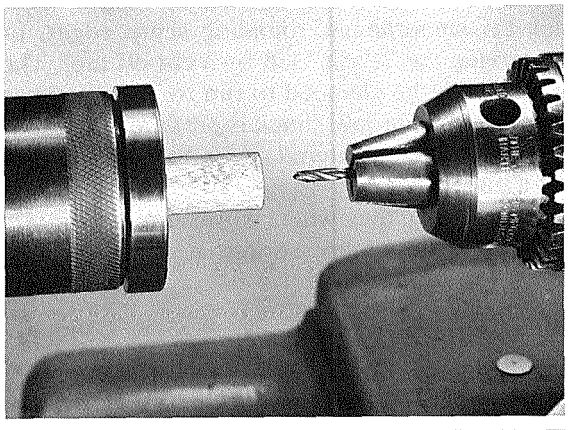
As with anything else, familiarity is achieved through steady practice. Work slowly and patiently at a number of projects and you'll find your speed increasing and the quality of your work improving. Perhaps the most important part of a self-training course is to perform each step in an operation with care until the whole routine of machining a part becomes second nature. Eventually you'll be able to achieve professional results with little effort.



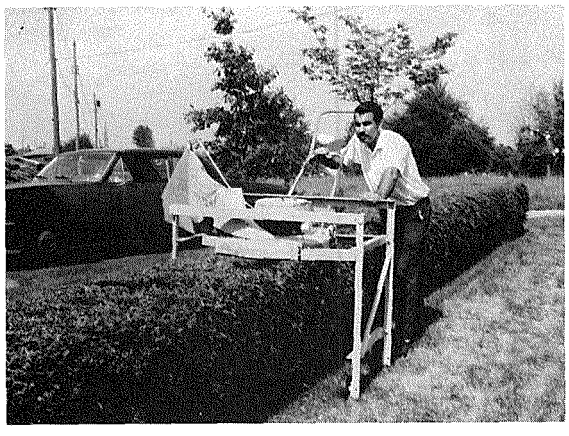
WHEN USING A DISC SANDER on a painted floor, I found the paper became so paint clogged before it was worn it was no longer effective. By using paint remover and cleaning off softened paint I got more mileage.—*B. W. Ervin, Kent, OH.*



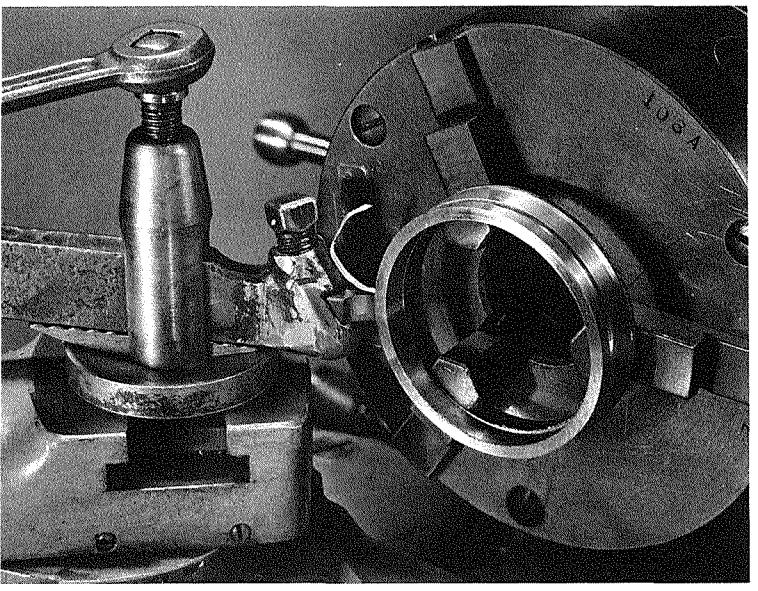
BY CLAMPING A ROUTER upside down, you can use it as a stationary tool to burnish scroll workpieces. Insert a short length of ¼-in. steel rod in the collet, tighten and feed the work against the spinning rod.—*Walter E. Burton, Akron, OH.*



WHEN END-DRILLING some hardwood dowels in a lathe, I found the small drill bit tended to wander off center. After inserting the bit deeply into the chuck, I was able to drill the axial holes accurately.—*W. B. May, Oak Park, IL.*



BY BUILDING the rolling gantry , left , I reduced my hedge-trimming time from eight to two hours. The rig, a welded angle-iron frame, supports my rotary mower. The ground on which the setup rolls must be level to produce a neat cut.—*Louis P. Bruno, Cheswick, PA.*



Turning rings on a lathe

By WALTER E. BURTON

RINGMAKING IS an exciting but often overlooked talent of the metal-working lathe. You can turn out sizes and shapes you could never buy—big, little, square, rectangular, triangular, oval, round, half-round, hexagonal, octagonal—you name it. You can make them of steel, cast iron, brass, aluminum, rigid plastic, even hardwood such as maple.

Turned rings are, of course, jointless. They have a handsome, elegant look that makes them ideal for pieces of jewelry and ornamental hardware. They can be used as decorative drawer and cabinet pulls, ladies' brooches and stands for models. Large rings can serve as bracelets or unusual picture frames.

The stock you use for making rings can be hollow tubing or pipe or solid bar material in round, hexagonal or other shapes. If you start with bar stock, you first bore out the center. Plain rings can be made simply by slicing sections off your stock like cutting a loaf of bread. If the width of the slice is the same as the wall thickness of your stock, you have a ring of square cross section. By making cuts at various angles, you end up with a ring of triangular, diamond, hexagonal or octagonal section.

As a matter of safety, it is not a good idea to let the stock project excessively beyond the chuck. The shorter the projection, the better. Chuck jaws can grip a tubular piece on either the outside or inside. Sometimes the outer end of a solid bar can be steadied on a tailstock center if you don't bore away the material at the bar's center until later.

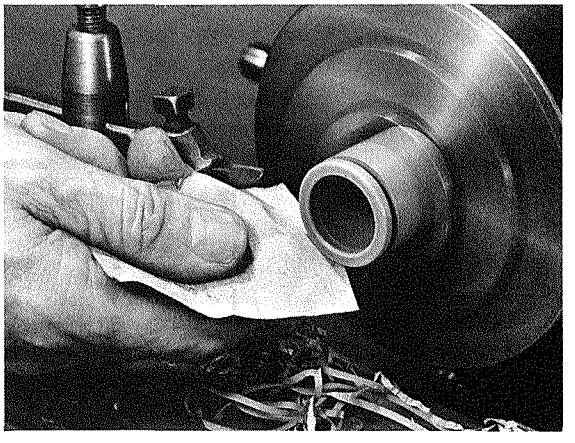
support and secure workpiece

When rings are to be cut from long stock, the piece should be supported near its outer end by a steady rest, as shown in some of the photos. The end toward the headstock should be gripped firmly by the chuck or lashed securely to the faceplate to prevent endwise crawl from occurring.

Single rings often are clamped in a chuck for minor finishing operations such as filing or sanding for smoothness, rounding sharp edges, or removing the "flash" left by a cut-off tool. The ring should be clamped to run true. Sometimes an independent-jaw chuck is preferable because the ring can be centered accurately with the aid of a gauge.

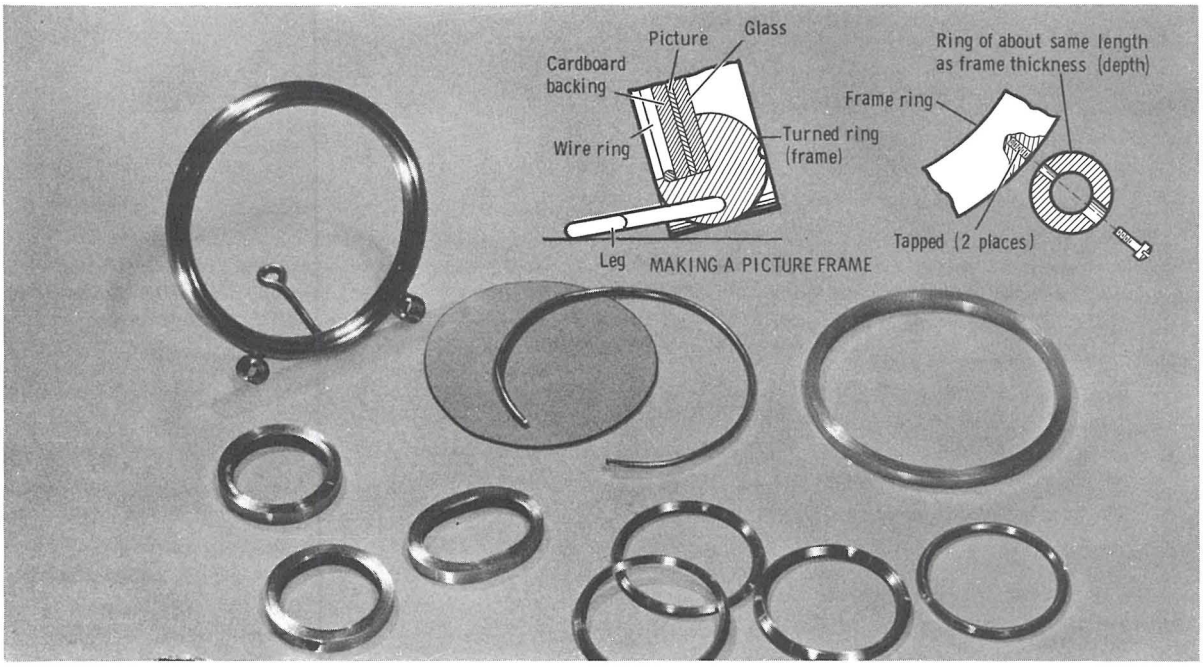
Remember that when you clamp a ring in a chuck, jaw pressure springs it slightly out of

PLASTIC RING, turned from a section of plastic plumbing pipe, gets a polishing below before final cut is made to separate it from the remaining stock.

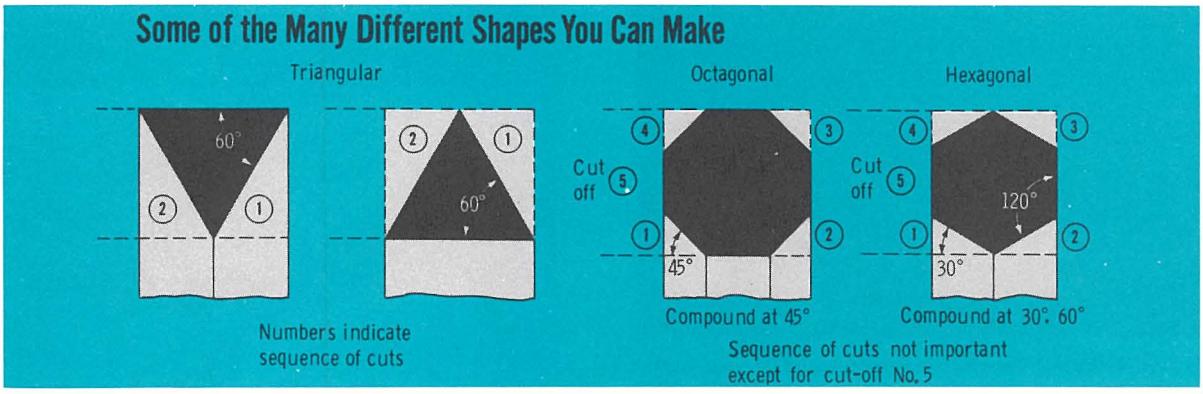


SEE ALSO

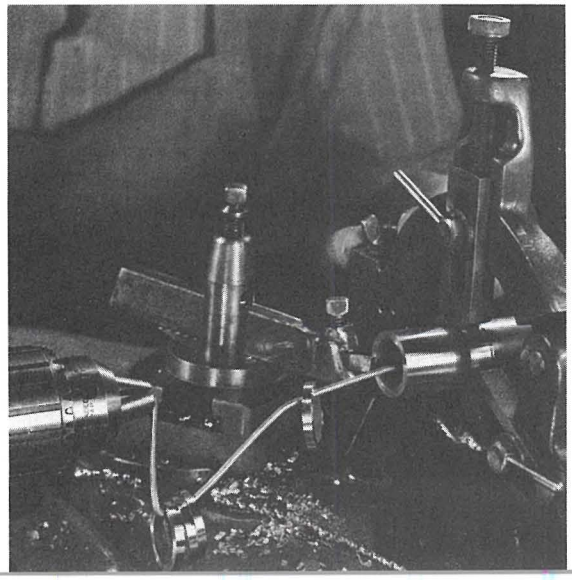
Drawers . . . Jewelry . . . Metal casting . . . Metal-lathe accessories . . . Modelmaking . . . Tubing, metal



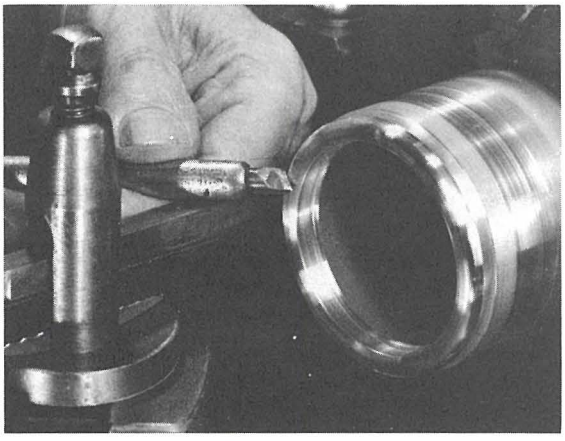
SOME OF THE MANY rings you can make are shown above. The oval ring to the left of center was made by squeezing a round ring with pliers to flatten it slightly. At the top of the photo is an example of how a large ring can become a decorative picture frame. A recess is machined at the back to hold the picture and the legs are added as shown in the sketch. Big rings of this type could also make interesting and novel ladies' bracelets.



RINGS DROP OFF one after another and slide neatly onto this automatic catcher. The simple device consists of a bent wire held in the tailstock chuck.



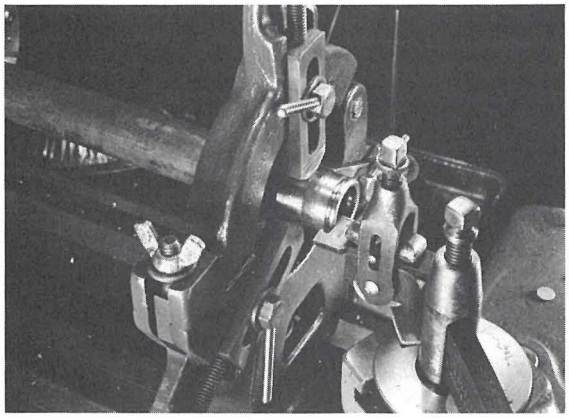
FREEHAND TURNING enables you to shape round, oval and other curved-section rings. The tool is handheld. A bar clamped in the toolpost serves as a toolrest.



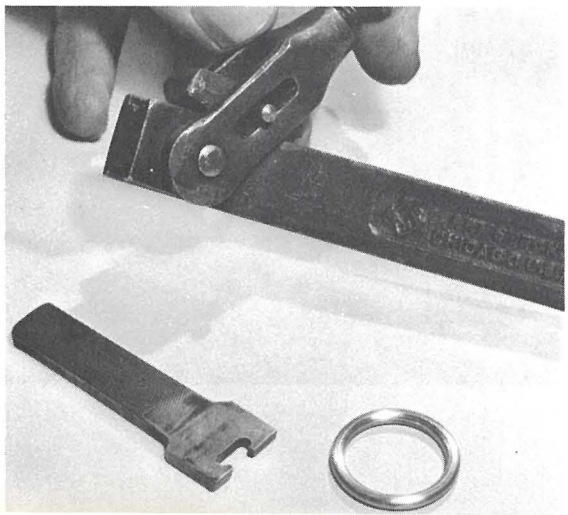
round. Tubular stock is similarly distorted near the chuck. A ring machined from a blank distorted in this way, will not be perfectly circular when jaw pressure is released. In most cases, this is probably not important, but it could affect ring fit in close-tolerance work, such as in making optical-instrument parts.

Metal, plastic and wood rings can be shaped freehand on a metal lathe in much the same manner as parts are formed on a wood-turning lathe, the tool being handheld and supported by a fixed rest.

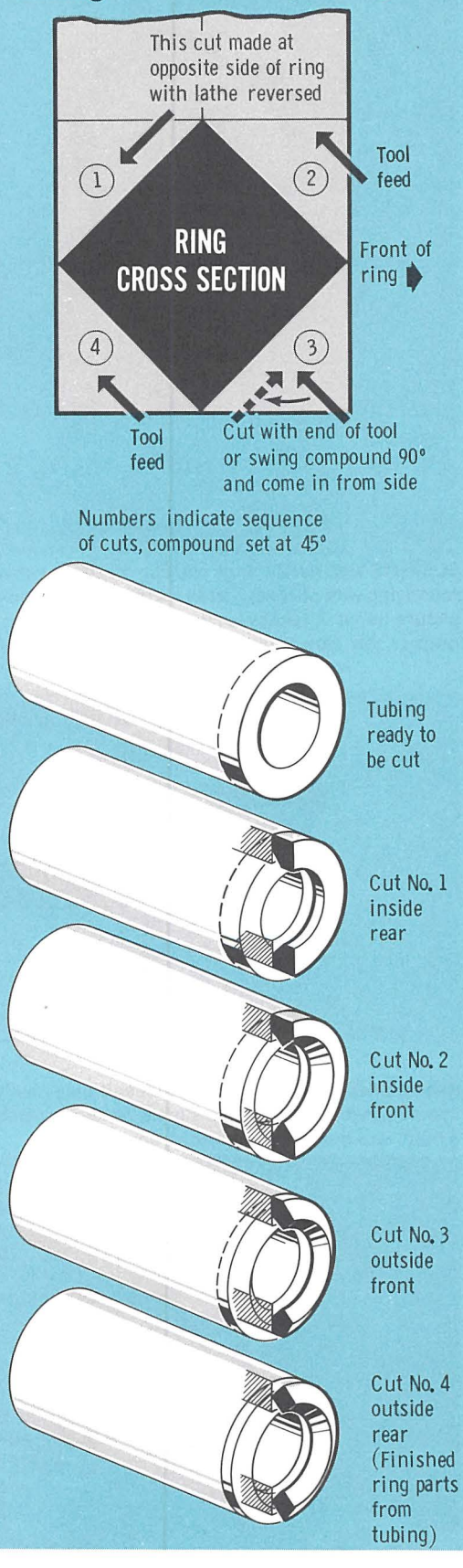
Carbide-tipped turning chisels are available for use on metal parts, or you can grind suitable ones from tool steel or high-speed-steel lathe bits. Various common wood-turning chisel shapes are useful in working metal rings. The skewer shape is particularly handy. Such tools can be manipulated to cut, rather than scrape, metal neatly from the work, with the formation of fine, thin chips. The hand-turning technique is

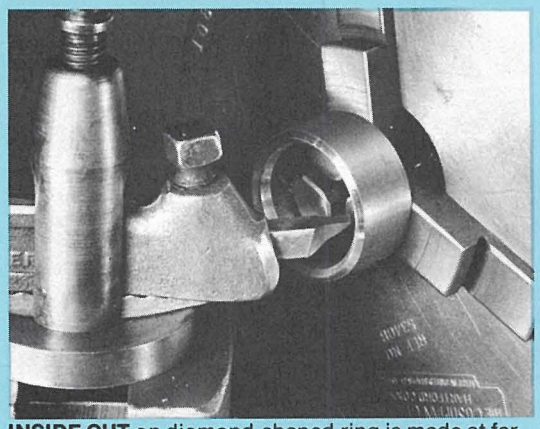


HOMEMADE BITS speed the work on special jobs, such as turning out round or oval-section rings in quantity. The one below, for round-section rings, was made from an old file. Two holes of ring diameter were drilled, the material between them removed, relief angles filled, and the tool was rehardened. The bit is held in a regular boring-bar holder as shown above.

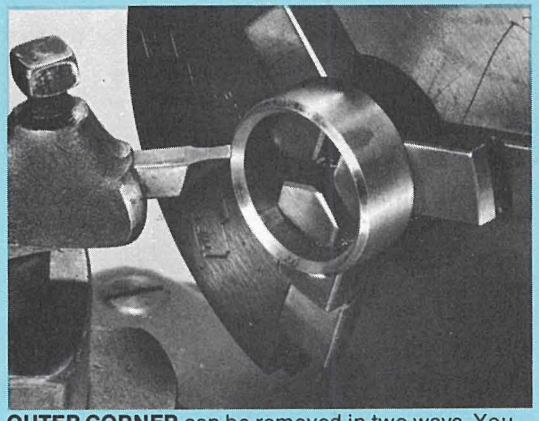


Turning a Diamond-Shaped Ring

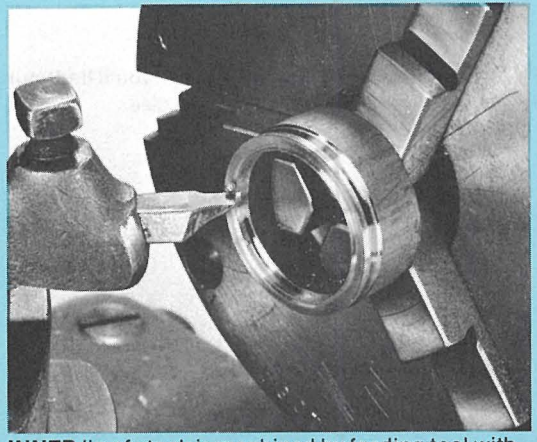

This cut made at opposite side of ring with lathe reversed
1
2
Tool feed
RING CROSS SECTION
Front of ring
4
3
Tool feed
Cut with end of tool or swing compound 90° and come in from side
Numbers indicate sequence of cuts, compound set at 45°
Tubing ready to be cut
Cut No. 1 inside rear
Cut No. 2 inside front
Cut No. 3 outside front
Cut No. 4 outside rear (Finished ring parts from tubing)



INSIDE CUT on diamond-shaped ring is made at far side of stock with lathe reversed. All other cuts are made at stock's near side.



OUTER CORNER can be removed in two ways. You can feed toward headstock, as here, using square end of bit, or swing compound 90° and feed from opposite.



INNER lip of stock is machined by feeding tool with compound-slide screw. Final cut has been started here, will be deepened later to part ring.

useful in shaping rings having round, oval, or similar cross section and in making decorative grooves and ridges.

Rings having diamond-shaped, triangular, hexagonal and octagonal sections can be formed by feeding the tool with the compound rest set at the proper angle. Here is a helpful way to work out the machining sequence: Draw a scaled plan of the desired ring cross section, showing it as if you were looking down on top with the side facing you representing the side toward which the tool will feed. With this, you can easily determine the angles, dimensions of various faces, and distances the tool must travel in making different cuts. These values are then used to control the movement of the tool bit by means of the micrometer collars on the carriage screws, particularly that controlling the compound slide.

numbers indicate cutting sequence

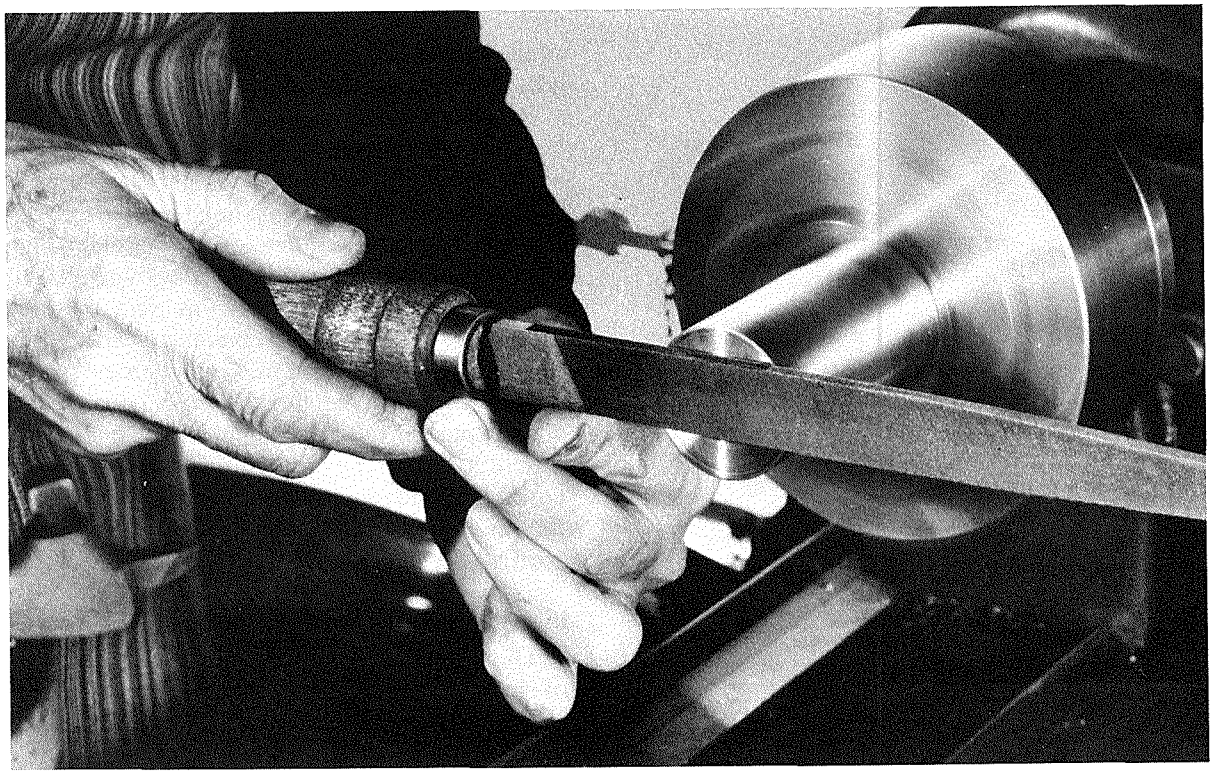
The drawings show the cross-sectional layout of rings of various sections. The numbered segments indicate waste material to be machined away. In some cases, the numbers represent a suggested cutting sequence, selected to make it easier to establish starting points for measuring tool movement.

You can make nonmetal rings from such materials as rigid PVC (polyvinyl chloride) pipe available in many stores. Such plastic material is machined much as if it were metal. It is easy to cut and requires only moderate tool pressure. Chuck-jaw pressure should be controlled according to the strength and bendability of the material.

A ring can be machined to serve as a frame for a round picture, plaque or other object. In the back of the frame, machine a recess to receive the picture, a glass or plastic cover if one is used and a piece of backing material, such as heavy cardboard. The simplest holding arrangement consists of an open ring of wire sprung into a shallow groove around the inside of the recess. Feet for the frame to stand on can be made from smaller rings attached to the main ring with screws, rivets or solder.

finishing the rings

You can finish turned rings in the same way as other items of the same materials. Files and abrasive paper or cloth are suitable for smoothing most materials. Rings can be given various distinctive textures by knurling them while they are in the lathe, or by some other suitable treatment such as peening, engraving or stamping.



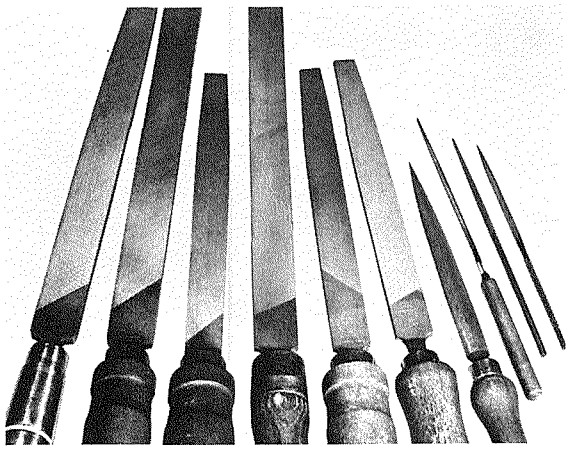
Filing on a lathe

■ A FILE IS MORE than just a useful lathe tool. True, it will produce a fine finish—smoother, in fact, than that made by the turning tool. But it can also reduce a diameter by the merest fraction of an inch or millimeter—or it can rapidly cut down a shaft for a drive fit in a pulley or a running fit in a bearing.

In seconds, it can whack off the center tip left by a cutoff tool as shown in the above photo. It can make and smooth round, vee, or other odd-shaped grooves and fillets on turned work. A file can also serve as a miniature taper attachment for such operations as converting rod sections into taper pins, and it can quickly produce a neat point on punches and scribers. A pair of files can be manipulated to smooth and size simultaneously a small-diameter rod that's too limber for regular machining.

In fact, almost any type of file could be used in some form or other for lathe work. A common, single-cut, mill file can do a good job of smoothing turned work such as a shaft. Conventional three-square or triangular files are handy for touch-up work on small shoulders and grooves.

AS YOUR LATHE FILING needs increase, you'll find your selection of lathe files growing to this size.



SEE ALSO

File racks . . . Metal-lathe accessories . . . Sharpening, tool . . . Tools, hand

For very fine finishes, or delicate shaping and sizing, Swiss-pattern files are often used. Even a conventional ignition file is handy where a thicker one would not do the job.

Thus, the lathe owner will indeed find it worthwhile to obtain one or more "lathe files." These are similar to conventional mill files, but their tooth angle is steeper, so that they cut with a more pronounced shearing action. This results in less clogging, smoother cutting, less chatter, more freedom from drag and faster cutting action—but they tend to crawl sidewise a bit more readily than a conventional file. On a sample mill file, the tooth angle (measured with respect to file length) was approximately 65°; tooth angles on similar lathe files are 45°.

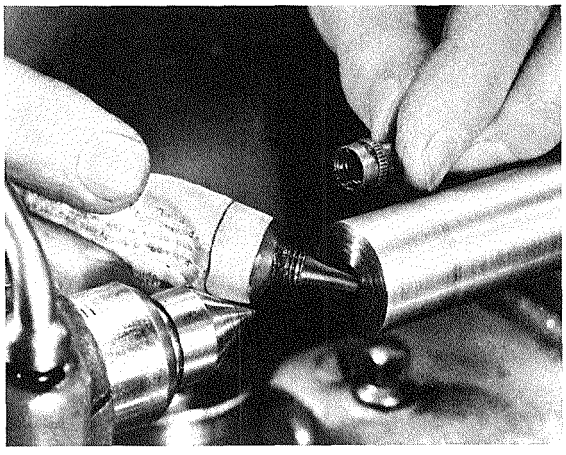
Perhaps you can handle most of your routine lathe filing with as few as two files: a 10 or 12-in. lathe file for rapid, rough work, and an 8-in. lathe file for finishing. For greater all-around filing flexibility, however, you may want to supplement these with other files.

As a start, the Nicholson File Co. suggests: a 12 or 14-in.-long-angle lathe file for operations where a considerable amount of stock is to be removed rapidly (as when sizing a shaft for a drive fit in a pulley); a smooth-cut mill file for producing a smooth finish (as on a shaft where it is to run in a bearing) and a Swiss-pattern, hand or pillar file in No. 4 or No. 6 cut, for a very fine, smooth finish.

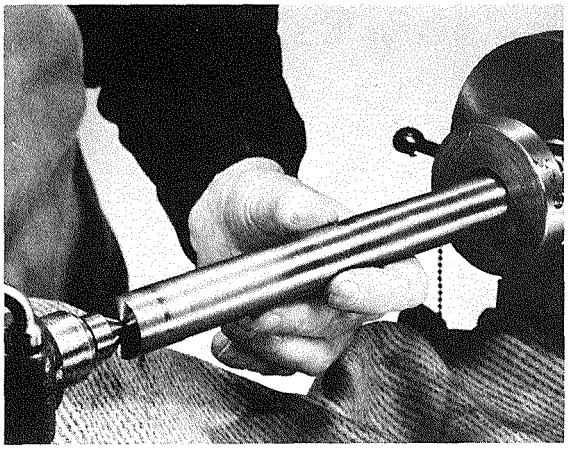
For a fine, *polished* finish, consider making an "abrasive file"—it's simply a strip of fine-grit or well-worn aluminum-oxide or silicon-carbide sheet abrasive. Tack or glue it to a flat wooden stick, or to a stick shaped for polishing contours.

Procedures for filing work in a lathe are not very complicated. The workpiece can be mount-

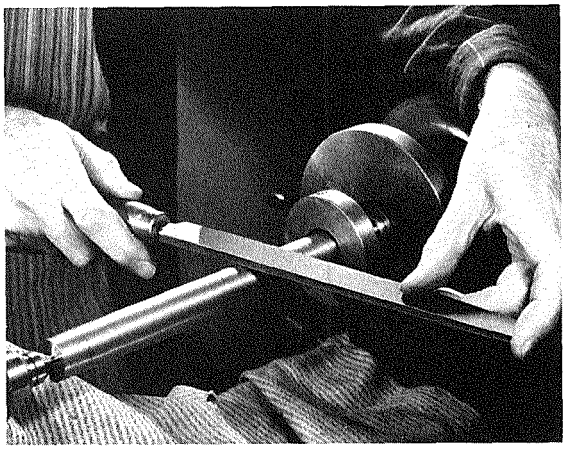
SINCE FRICTION will heat the work and cause it to expand lengthwise, centers must be well lubricated.



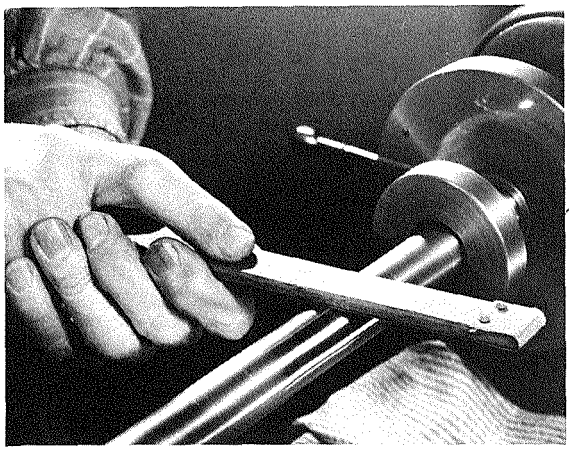
LATHE CENTERS should not be tight, but should have enough play to allow a slight workpiece movement.



A COARSE, FAST-CUTTING FILE can be used in the first stage of filing, keeping it at a right angle to the work.



FOR A FINELY POLISHED surface, an abrasive file can be made of a stick and strip of abrasive cloth.



ed in a chuck or collet, or between centers. If between centers, remember that filing friction can cause the workpiece to heat-expand lengthwise and bind on the centers. To prevent this, put a little oil on the headstock center, and liberally lubricate the tailstock center. Then adjust center clearance so the workpiece can move freely.

Stop the lathe occasionally during prolonged filing and check for possible binding. If any squealing develops where the workpiece revolves on the tailstock center, stop the lathe immediately, loosen and relubricate.

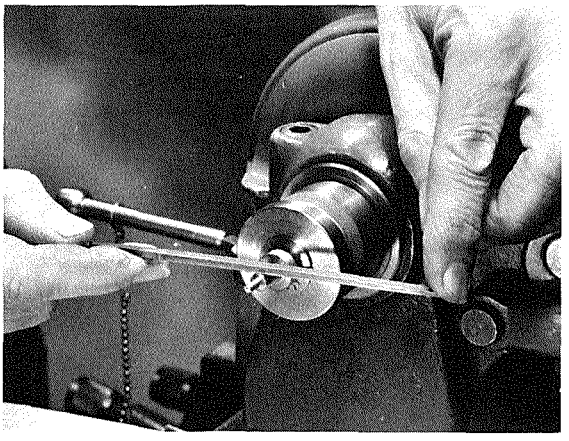
For finish filing, run the lathe at a high speed—especially for any small-diameter work. But for simply filing off a sharp edge or tip, normal turning speed will do.

With smooth, even and medium-pressure strokes, keep the file moving across the revolving work. Normally you should hold the file square with the work axis, or nearly so. You may find, however, that a smoother overall finish results if you move the file in a slightly diagonal path.

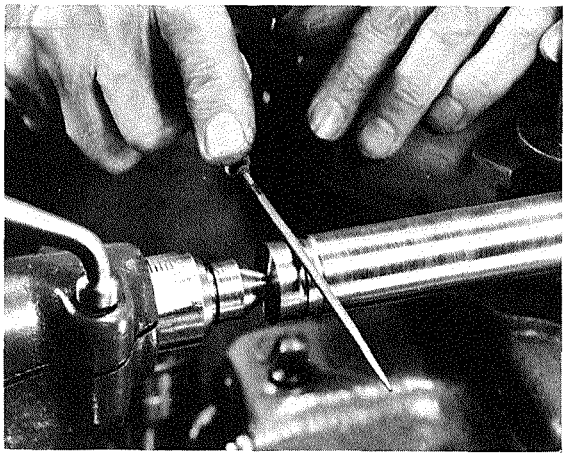
If the file begins to lose its bite, or if it tends to skip or cause streaks on the work, clean the teeth with a file card or small wire-bristle, suede-shoe brush.

Although file technicians suggest that the surface be oil-free, you may find that a sulphurized cutting oil or similar fluid can be helpful. When filing a rusty shaft, a dash of cutting oil will minimize nose-irritating dust and also reduce the depositing of filings on the lathe bed and carriage. A sulphurized cutting oil I used on various occasions seemed not to decrease the files' efficiency, and perhaps it tended to reduce tooth wear. But because the oil does hold filings in the

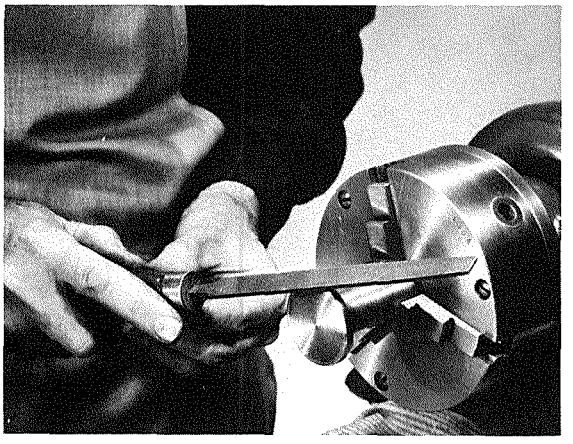
SMALL SWISS-PATTERN FILES are handy for shaping and smoothing small parts. In the photo below a dimpling punch is being used for this purpose.



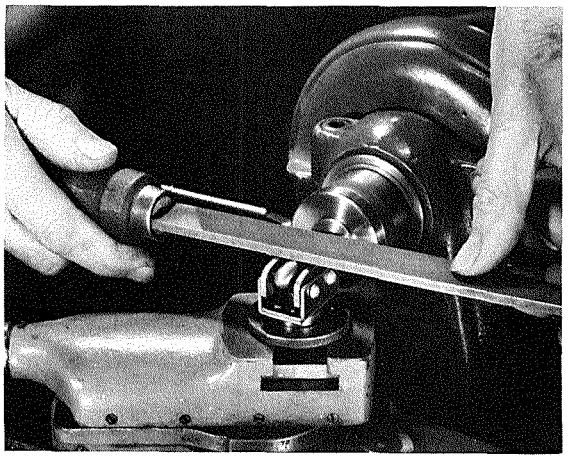
GROOVED SECTIONS can be made or smoothed by using an appropriately shaped Swiss-pattern file. If you do much fine work, you'll want to purchase a set.



DISC-SHAPED SECTIONS where a precise radius is not required can be both shaped and finished with files. As shown here, the file is hand-held.



AN EASY-TO-MAKE GUIDE helps control the depth of degree of filing. This kind of guide is especially handy for producing bullet or dome shapes.



teeth, the accumulations had to be wiped off after just several strokes of the file.

Regular lathe files have "safe" edges—that is, the edges are smooth, without teeth. The file thus can be used close to a chuck or other part without tending to bite into it. If you use conventional files lacking such safe edges, be careful that the edge doesn't touch any moving surface. One practice is to grind toothed edges smooth before attempting to do lathe filing.

When filing work that is revolving in a lathe, use sensible safety precautions. Hold the file firmly, and be careful that it does not catch on the workpiece to be tossed your way, or become entangled with a chuck.

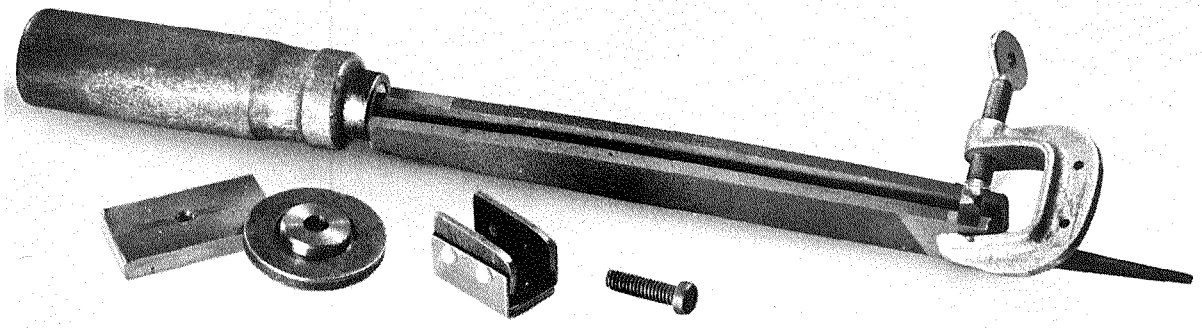
It's always a good idea not to stand directly in line with the file handle. When you reach over the lathe to grasp the outer end of the file, be careful not to be grabbed by the chuck or dog. On your forearms, wear tight-fitting sleeves or, better yet, none at all.

taking care of files

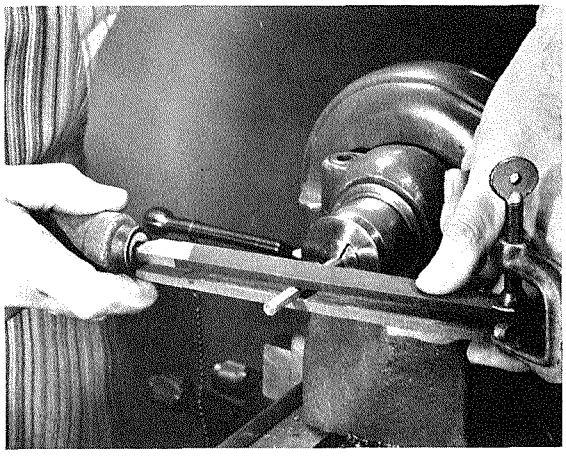
The life of a lathe file can be greatly reduced by improper care or carelessness. Never throw a file into a drawer or toolbox—also avoid stacking them on top of one another. Instead, always keep them separate by hanging them in a rack placed out of the way so they won't be knocked off accidentally and damaged.

Before storing the file, however, make certain that all chips have been brushed out of the file ridges. If oil or grease is left on the file, it can be removed by wiping with a soft clean cloth, then rubbing chalk into the file teeth. A soft iron "pick" should also be kept on hand for removing troublesome filings that may become imbedded in the teeth.

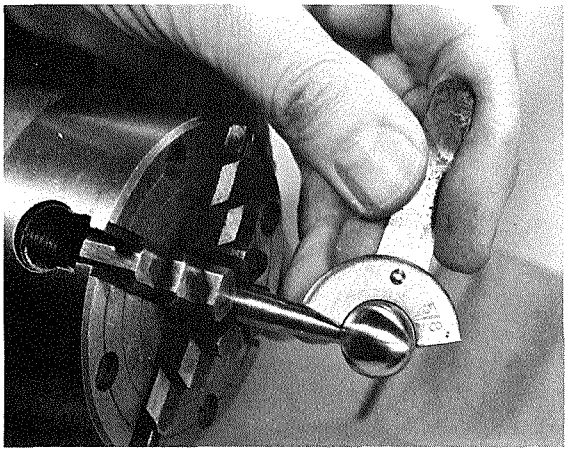
FILING ATTACHMENTS and accessories include a filing guide and two-file assembly for thin limber rods.



A DOUBLE-FILE ASSEMBLY should be used at high speed. The cutting pressure is set by squeezing the open end to produce the desired diameter.



A SIMPLE BALL-TURNING GAUGE can be formed from a suitable washer, then used to check the ball diameter. Continue until you get a snug fit.



The knack of knurling

By WALTER E. BURTON

To get a good grip on a grimy, oil-covered tool you need some knurls. Knurling can also increase the outer diameter of a rod or reduce the inner diameter of a tube

LUBRICATING OIL or cutting fluid should be applied to both the knurls and the work surface. This will help produce a clean-cut knurl.

SEE ALSO

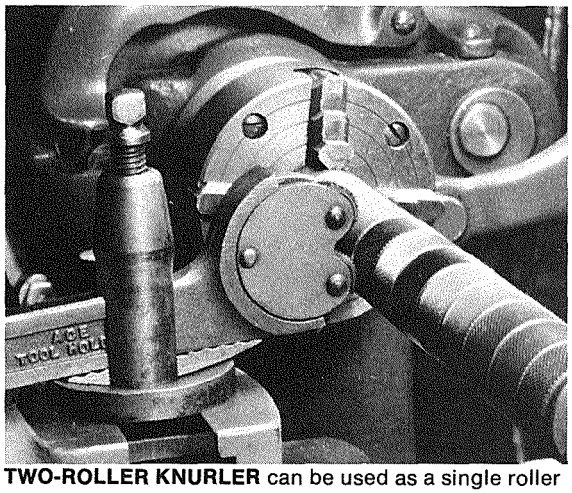
Metal-lathe accessories . . . Tools, hand

■ SOMEHOW, it always seems that metal-turned projects are twice as handsome after they're knurled. Yet, aside from improving the appearance of a tool, knurling can serve other important uses.

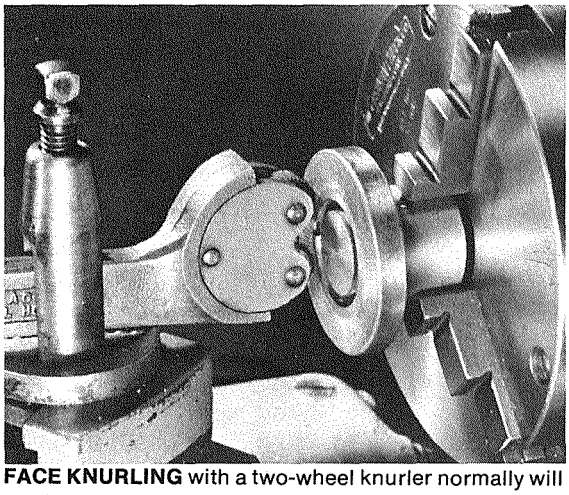
The foremost advantage of a knurled tool is the good grip you achieve. Even when coated with an oil slick, a knurled tool can be wielded with ease and safety.

There also are a few mechanical functions that knurling can perform, such as slightly increasing the outer diameter of a rod, or reducing the inner diameter of a tube or cylinder.

Ordinarily, knurling is accomplished by forcing one or two ridged rollers against a revolving piece of work. The sharp ridges, or teeth, may run either straight or diagonally across the roller surface. On a pair of diagonal knurls, the ridges run in opposite directions so they will produce crossed helical grooves or a diamond pattern on the work. Such a pair of rollers is commonly used for most home-workshop metal-turning and usually is mounted in a rocking head that's self-adjusting for even pressure. Another useful type of knurler has only one roller; you can make such a tool if you cannot find one.

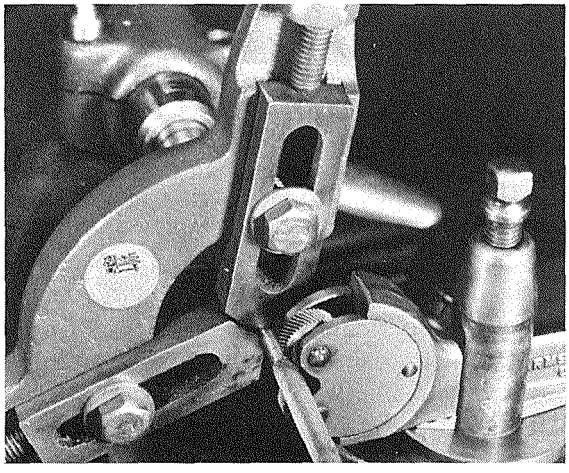


TWO-ROLLER KNURLER can be used as a single roller tool simply by positioning. Be sure that the lower roller is all that contacts the work.



FACE KNURLING with a two-wheel knurler normally will produce the desired diamond pattern. This is dependent upon the radius of the knurled areas.

SPRINGY ALUMINUM ROD is held against the knurls by a follower rest which is bolted to the lathe carriage. In such cases, be sure to use plenty of oil.



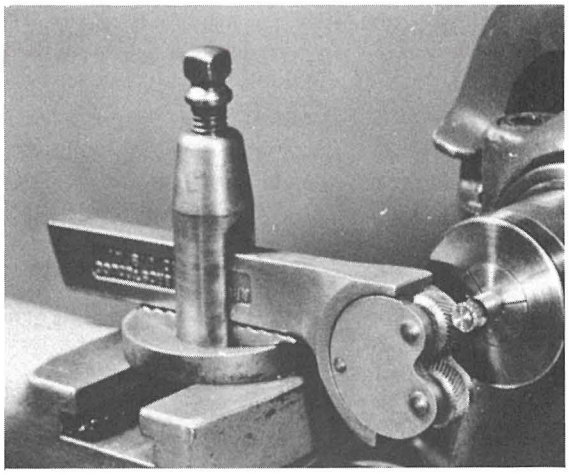
various roller sizes available

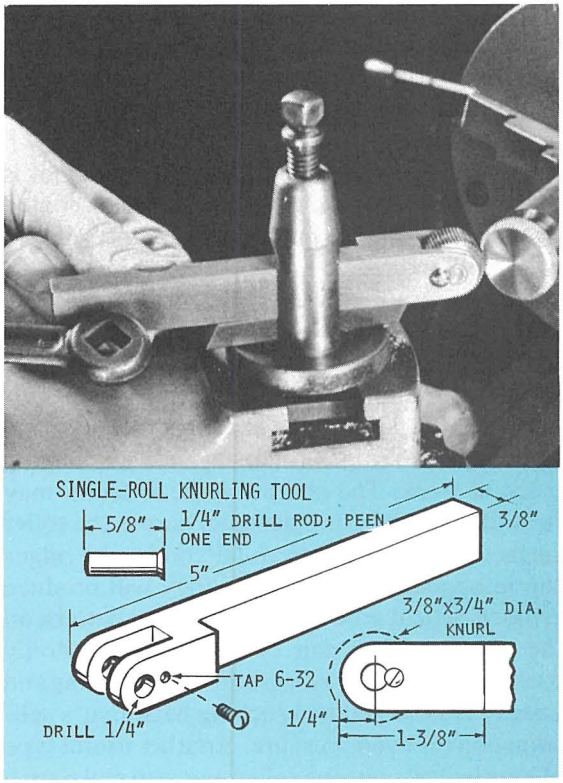
Knurling rollers are obtainable for use in custom-made tools and for replacing worn rollers. They come in various diameters, such as the ⅝ and ¾ in. sizes shown in the photos, and with different numbers of teeth per inch (pitch). In general, knurls are classified as coarse (14 pitch), medium (21 pitch) and fine (32 pitch). For most of your requirements, a pair of medium-pitch diagonal knurls in a conventional two-roller holder, like that shown, is sufficient.

Mounting the work: When its length is adequate, a piece of work can be mounted either between centers, or with one end in a chuck and the other end supported by the tailstock. To resist crosswise pressure applied by the rollers, the center holes in the workpiece should be fairly deep and well-lubricated.

If a chuck is used, the workpiece end should rest against the chuck body or a stop positioned in the headstock-spindle hole. Be sure the tailstock and its spindle are locked securely to resist pressure.

Starting the cut: Whether or not a knurl will track properly is usually determined during the first revolution of the workpiece. Position the knurler so one-half of the roller width overhangs the tailstock end of the section to be knurled.





TWO-ROLLER knurler (above) can also be inverted so that only one roller contacts the work (in this case, a small thumb screw). A diagonal pattern results. A straight knurl can be used on the bevel of a knob or rod (above right). Here, the circumference of the brass knob has been knurled in a diamond pattern. Details of a one-roller knurler (right) can be used to make your own. The rollers are standard sizes.

Bring the rollers squarely against the work. (When knurling some of the harder metals, a knurler is sometimes swung at an angle.)

Rock the workpiece back and forth while using the cross-feed screw to press the knurls against the surface. In this way, force the knurl against the work to make a cut about 0.045 to 0.050 in. deep. Then turn the workpiece through a full revolution (by hand) and continue turning into the second revolution while checking that the teeth track in the cuts they made during the first turn. If they do, the knurl should continue to track properly and you can proceed under power. Some operators back off the cross-feed screw a bit, to reduce pressure, before starting the longitudinal feed.

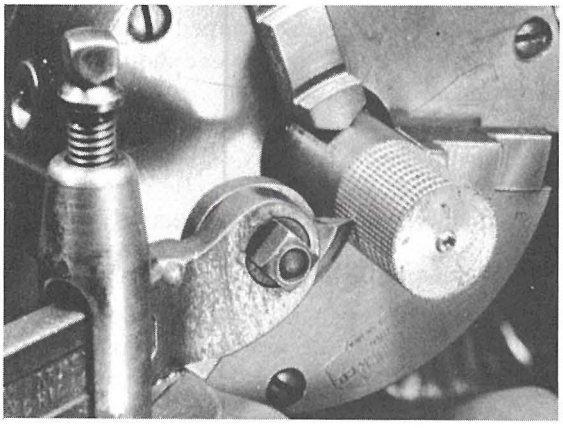
At first, try running the lathe at its slowest speed, using the back gears. With experience, you'll find the best knurling speeds for your particular lathe. As a general rule, however, 1-in. steel rod can be knurled at about 160 rpm, or 40 surface feet per minute. Apply plenty of lubricating oil or cutting fluid to both the knurls and the surface being knurled. Oil should also be applied to the steady-rests or follower-rests whenever they're in use.

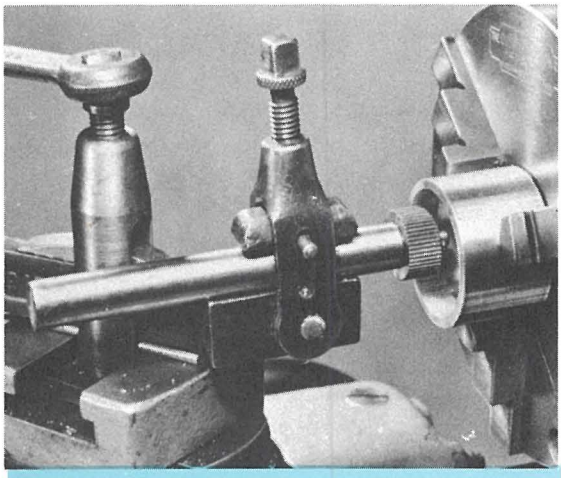
Initially, try using a feed of 0.025 to 0.050 in. per revolution, applying the slower feed for the harder metals. On soft metals, such as aluminum, a full diamond pattern can be produced with a single pass. Commonly, however, several passes will be required, each with a slight inward movement of the knurler via the cross-feed screw.

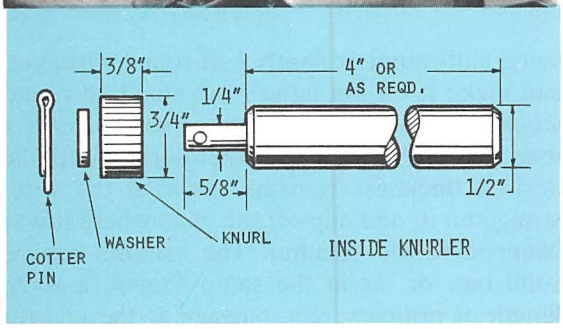
Knurls can be moved back and forth along the work without jumping out of the pattern as long as they are pressed firmly against the work surface. Even when removed from the work, a knurler can often be repositioned (by hand) so the knurls will re-engage the indentations.

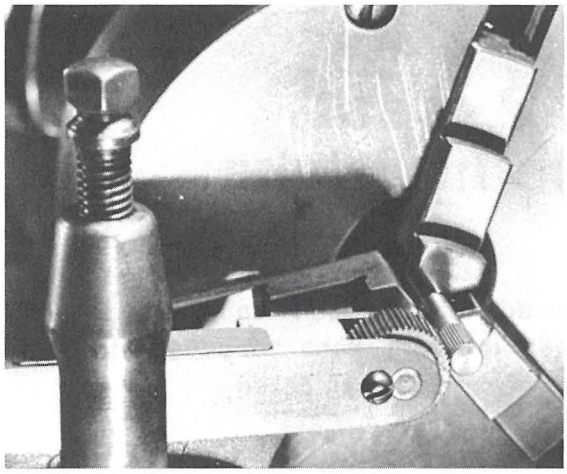
With a single-roller knurler, you can sometimes cure defective tracking by increasing the pressure on the cross-feed screw. The knurl will roll out the first off-pitch marks. This technique,

NOVEL PATTERN can be produced by threading rods that have been previously knurled in a straight pattern.









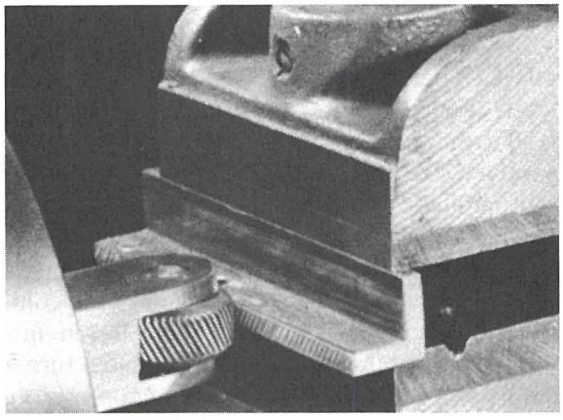
KNURLING INSIDE a cylinder is easy with a single roller tool (above left). Inside knurling can also be used to decrease the i.d. of a tube. Straight-knurl the end of a ¼-in. rod (above) to increase its o.d. and make it fit tightly in a slightly oversize hole. Again, oil is essential. Details for a simple, single-roller knurling tube (left) will enable you to knurl inside cylinders using a commercially available roller.

however, is less likely to work when a two-roll knurler is being used to develop a diamond pattern. In this case, a fresh start in a pattern of sufficient depth will roll out the marks of false starts.

Although a full diamond or other pattern can be produced only by feeding the knurls inward enough to fully shape the ridges or domes, a partial knurl may be adequate. This is produced by cutting to less than full depth.

One solution to get the knurls to track properly is to start the knurling at the end of the area with considerable pressure and a deep cut, then ease back on the cross-feed so the knurls will cut a partial pattern the rest of the way. Finally, the starting band produced by this method will have to be machined off. An alternative solution, however, is to start the knurl on a slight ridge, which will be machined down later.

FLAT SURFACES can be knurled. Lock tool in the chuck and work in a milling vise. Feed with cross-feed screw.

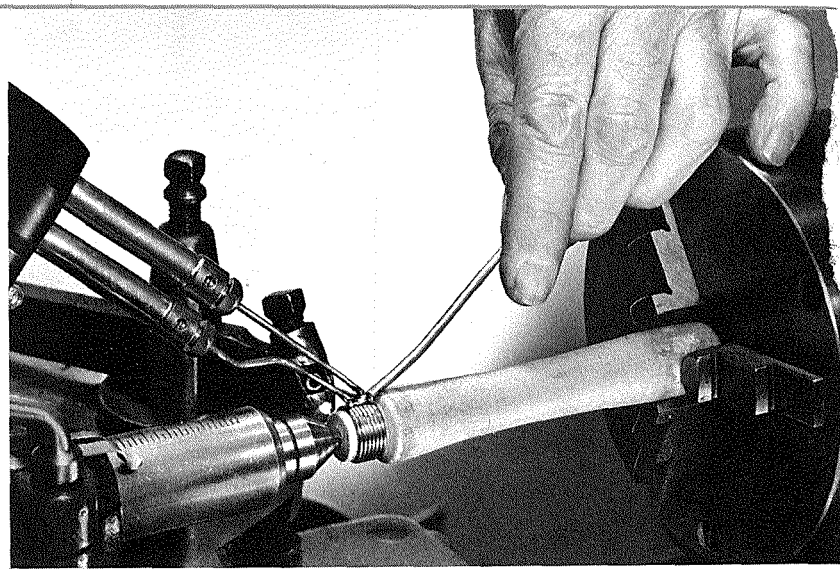


Normally, knurled areas can be finished by polishing with a fine abrasive cloth or wire brushing to remove chips. With partial knurling, the work can be filed to remove projecting burrs, leaving only the depressions made by the teeth of the knurler.

Soft materials, such as aluminum and brass, have a tendency to flake when knurled. The resulting chips should be wire-brushed from the work and knurl teeth.

Increasing a diameter by straight knurling provides a way of obtaining a tight fit between two parts, such as a stud in a hole, or two tubular sections. With a stud or a rod, the portion to be inserted is machined to the size of the hole or slightly less and then knurled. If it is hardened, it cuts a series of splines as it is driven into the hole to produce a tight joint.

With a tube, however, knurling will produce only a decrease in the inner diameter unless the tube is fitted on a mandrel. This is especially true of thin-wall tubes where the knurling pressure would normally decrease the inner diameter much more than it would increase the outer diameter.



12 great lathe tricks

Part of the fun of working on a lathe is that there seems to be no end to the innovations that you can try. Here are an even dozen

A FASCINATING ASPECT of lathe work is that it involves so many ways of doing so many things. There are countless shortcuts, tricks, improvisations and interesting accessories you can devise to save time, make the work easier, or do "impossible" jobs. Here are a few:

• *Banjo chuck wrench.* A handy friend with a lot of muscle, this wrench is jigsawed from ½-in. plywood. Radiating slots in the head, which is about the same diameter as the chuck body, are positioned to slip over the chuck jaws (photo, opposite page). When you apply torque with the wrench, the spindle is restrained by belt drag, by engagement of back gears, or by other braking action. The wrench shown is for a 5-in. chuck on a 9-in. lathe; it has a head diameter of 5 in. and a 1½ x 8-in. handle. The slots come within ½ in. of the head edge.

• *Cleaning lead-screw threads.* Dirt accumulations can be removed with a wood scraper clamped to the carriage apron. Trim the tip to fit thread grooves snugly, attach it to the carriage in whatever manner is convenient. Adjust the tip to ride smoothly in thread grooves with slight dragging action. The lathe is set as if cutting the same number of threads the lead screw has; in this case, the "cutter" is the thread-cleaning scraper. Carriage may move either toward or away from headstock, but it seems desirable to position the scraper so it trails the apron. This reduces the likelihood of a split nut in the apron accumulating a load of loosened dirt.

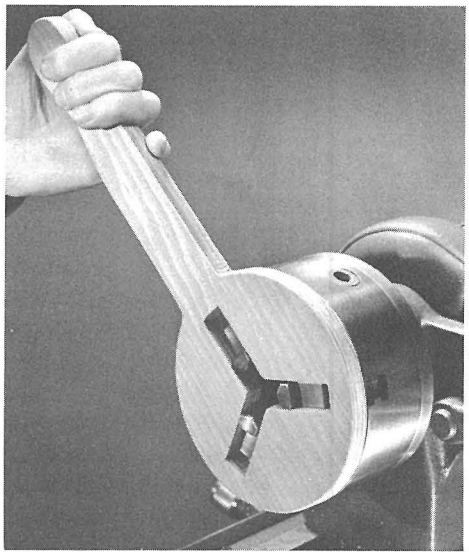
• *Making half-round wire or rod.* If you need some half-round or nearly half-round wire, you can make it on the lathe from standard round stock. Simply wrap a length of wire around a mandrel and machine the outer portion until the desired thickness remains. Unwind the wire, straighten it, and clip off the ends where it was clamped to the mandrel. The mandrel can be solid bar, or, as in the setup shown, a scrap length of ordinary pipe plugged at the end (or ends for between-center mounting) so the center hole can be drilled. Two short bolts, fitted with washers, clamp looped wire ends to the mandrel.

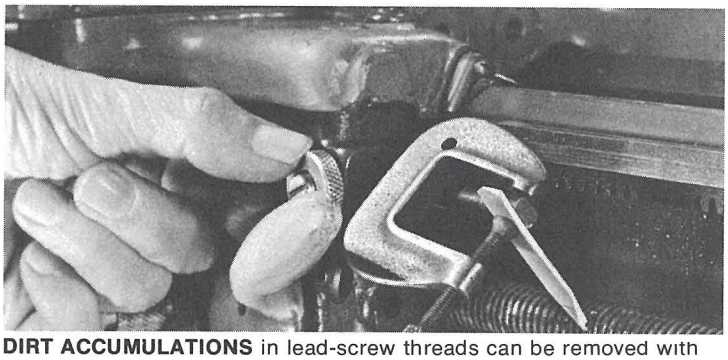
• *Angling compound slide for finer feed.* Lathes using the English system of measurement have cross-feed and compound-slide micrometer collars calibrated in thousandths of an inch. When the graduations are close together, it is difficult to control the feed to the precise thousandth. A trick worth knowing is to swing the compound slide to an angle of 30° or 60° with respect to the cross slide, and use the compound screw to control tool movement. Then, an .001-in. movement of the slide means a tool movement parallel to or at a right angle to the lathe axis of half the distance, or .0005-in.; thus, to get an effective tool movement of .001 in., the slide must be moved .002 in.

For controlling tool movement *parallel* to the lathe axis (lengthwise on the bed), as in adjusting depth of a facing cut, swing the compound slide to 30° from the cross slide. Then, when the slide is moved .002 in., the tool will move in a direction parallel to the lathe axis just half that distance. To control feed at a *right angle* to the lathe axis, set the compound slide 60° from the cross slide. Then each .002-in. movement of the compound slide changes the tool feed by .001 in. in a direction perpendicular to lathe axis. To turn a shaft using the *cross-feed* screw to control tool

SEE ALSO

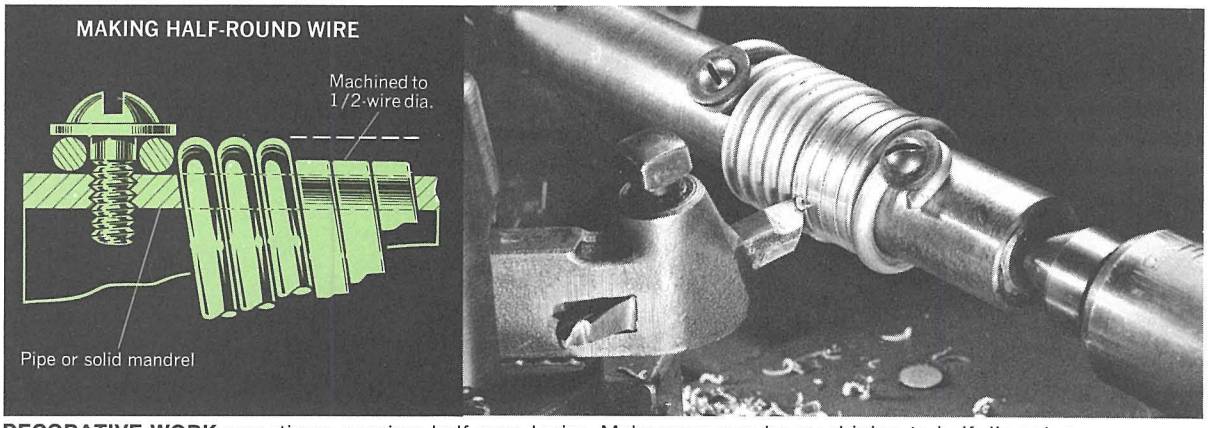
Machining . . . Metal-lathe accessories . . . Threading . . . Tools, hand . . . Tubing, metal





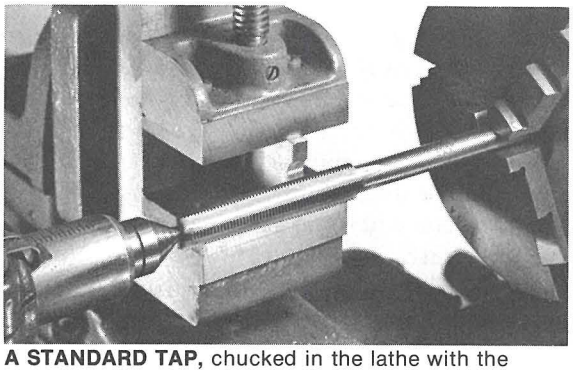
DIRT ACCUMULATIONS in lead-screw threads can be removed with bamboo or a wooden scraper clamped to the apron.

A BANJO-SHAPED WRENCH is a handy persuader when the chuck is stubborn and refuses to loosen from the headstock spindle.



DECORATIVE WORK sometimes requires half-round wire. Make your own by machining to half diameter.

A PROTECTIVE CARDBOARD COVER on the lathe bed makes cleanup easier and keeps gritty chips from the ways.

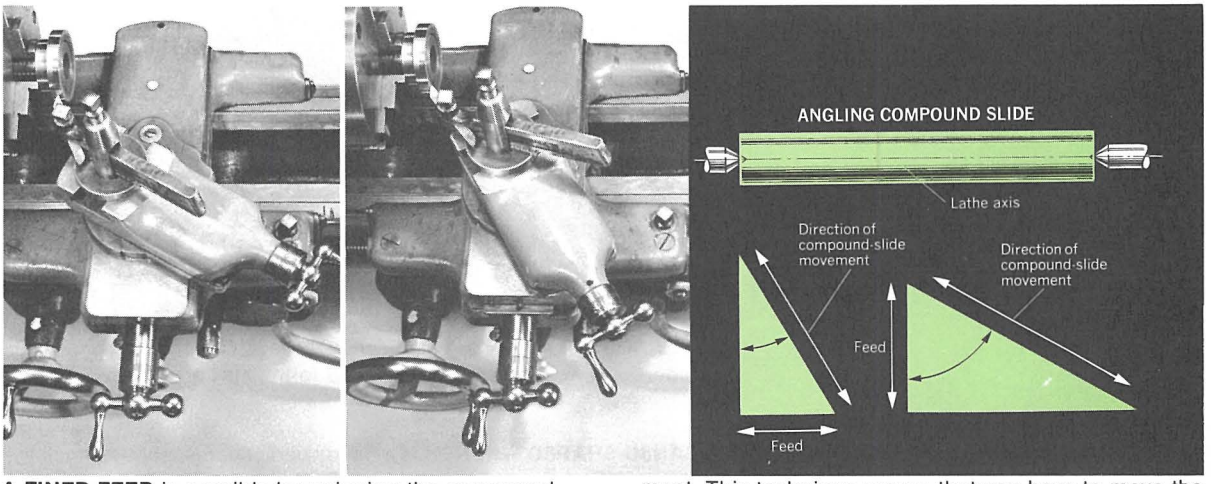


A STANDARD TAP, chucked in the lathe with the outer end held by the tailstock center, can serve as a milling cutter.

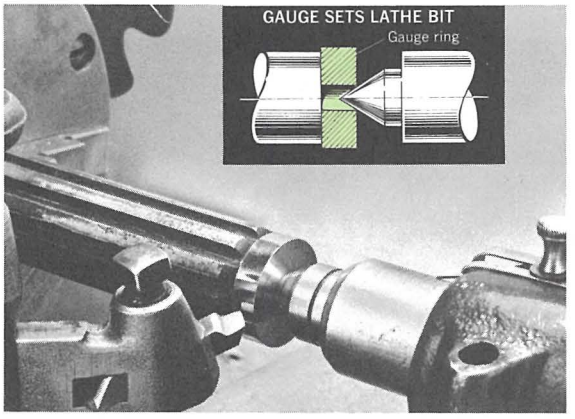
movement, you move the screw so that the micrometer scale will indicate one half the desired reduction in workpiece *diameter*.

For instance, to reduce the diameter by .006 in. in the next cut, you would turn the screw until its scale indicated a movement inward of .003 in. But with the compound slide set at 60° and used to control the tool feed, you would change the scale reading .001 in. for every .001-in. reduction in workpiece *diameter*.

- *Nut mandrel for collet chuck.* A useful adjunct to a set of collets is an assortment of mandrels on which to machine nuts. Each mandrel can be a 2-in. length of steel rod that will fit the largest collet, and having at its end a threaded stud to hold the nut (such as ¼-20).



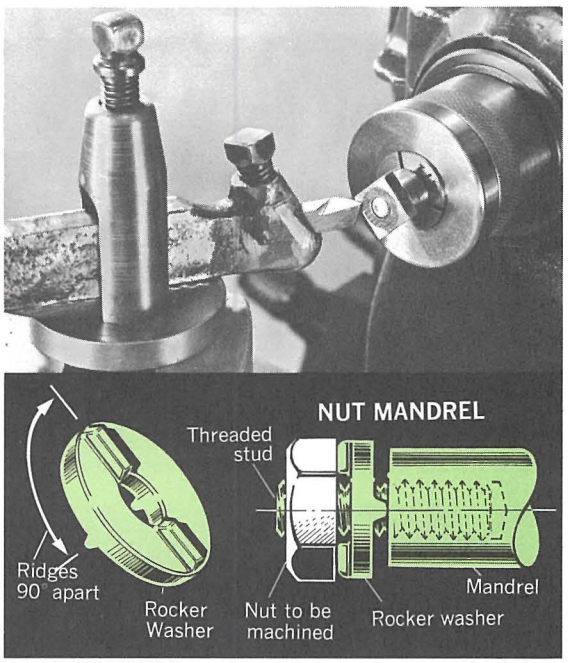
A FINER FEED is possible by swinging the compound slide to the desired angle and using it to control movement. This technique means that you have to move the slide twice as far as you normally would.



A MICROMETER TEST GAUGE provides an indirect way of turning work between centers to a definite diameter.

• *Gauge sets lathe bit.* An indirect way of turning a piece of work between centers to a definite diameter is to set the tool with the aid of a disc (or ring) of known diameter that has a concentric hole—such as a micrometer test gauge. The stunt can be used to achieve a fairly accurate final diameter when you machine work, such as a shaft with an odd number of flutes that is difficult to make directly. Or it can be used when no micrometer is available. The test disc is positioned on the tailstock center, and the squared end of a chucked bar or tube brought against it to hold it in place. The tool tip is brought into contact with the test-disc edge, and the reading of the micrometer collar is noted. From that point, settings for other diameters can be calculated. Thus, using a 1-in. gauge disc like that shown, the tool bit is fed inward from the gauge-edge position a total of .125 in. to produce a turned diameter of .750 in.

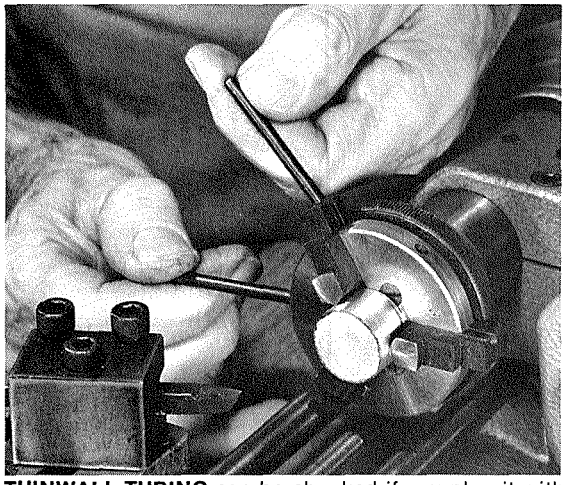
• *Tap used as milling cutter.* A conventional tap chucked in a lathe, with its outer end supported by the tailstock center, can be used as an emergency milling cutter. In the photos, a ½-in. tap is forming a semicircular notch (having a ¼-in. radius) in a bar of ¼-in. aluminum held in a milling-attachment vise. The feed can be all toward the axis, or each cut can be started at the tip of the tap, and the carriage moved toward the headstock until full tap diameter is effective.



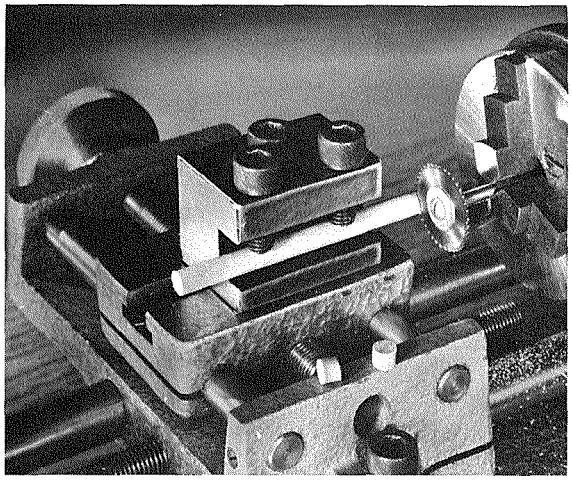
A NUT MANDREL can be made of a short length of steel rod with a threaded stud at one end to hold the nut.

• *Chucking thinwall tubing.* An often overlooked stunt is to plug thinwall tubing before clamping it in a lathe chuck. Plugging prevents chuck jaws from bending the tubing wall inward too far, and the plug is easily knocked out when the work is done.

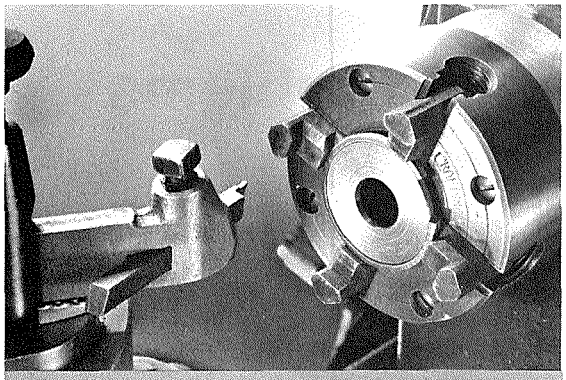
• *Small lathe uses hand-grinder accessories.*

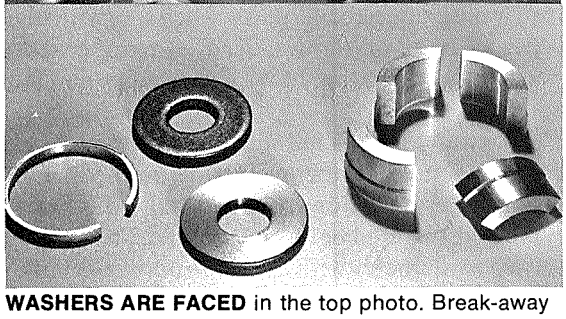


THINWALL TUBING can be chucked if you plug it with soft pine before clamping it in the lathe chuck.

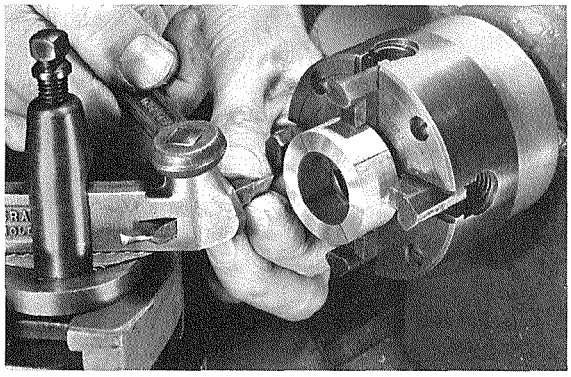


AN ASSORTMENT of brushes, pads and the like that come with a hand grinder expands small-lathe abilities.





WASHERS ARE FACED in the top photo. Break-away rings, (bottom), are machined by making the cuts first.



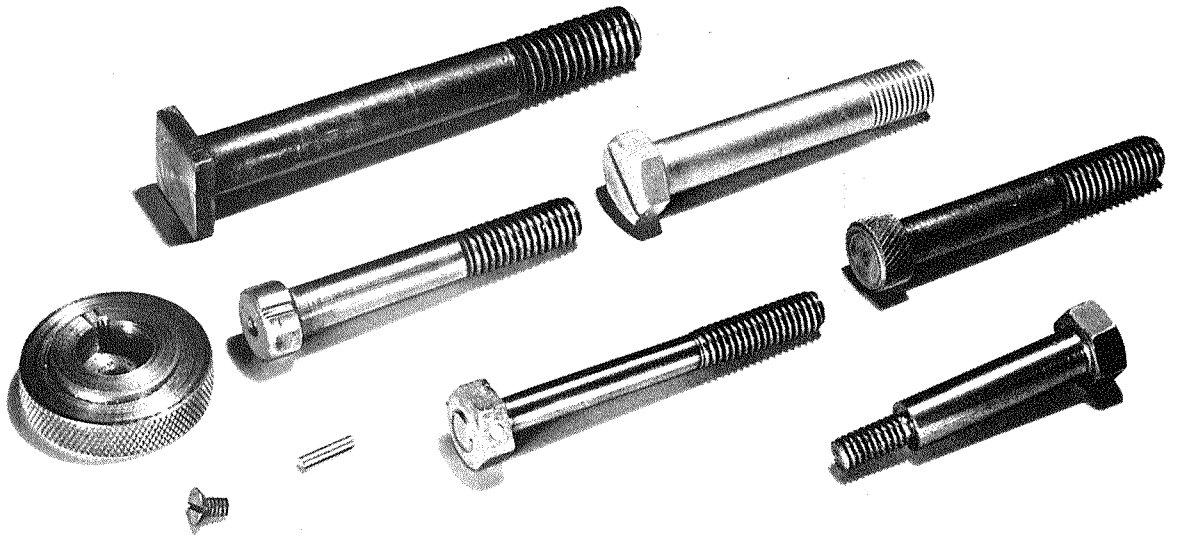
THIS ALUMINUM RING consists of four segments epoxy-glued together before machining to the finished size.

The assortment of cutters, brushes and the like that comes with a "motor tool" expands the capabilities of a small lathe. The tool shank generally is clamped in the headstock chuck, and the work fed to it by hand or with the aid of carriage and toolholder block.

• *Ferrules soldered on lathe.* When making a ferrule by wrapping wire tightly around a wooden handle mounted in a lathe (photo, page 1984), you can anchor the turns by applying solder to the wire while it's still under winding tension. This should result in a tight ferrule. The starting end of the wire is inserted into a hole drilled in the handle; the other end is trimmed off and remaining sharp points are removed.

• *Holding washers for facing.* To hold a washer in a lathe while its face is machined, encircle it with a split ring cut from another washer of the same size. The ring provides an area between washer and chuck jaws in which the lathe tool can operate without striking jaws. Split the ring with a saw cut, and expand it until it can be pushed snugly over the edge of the washer to be machined. Place this combination in the chuck so that none of the jaws come at the split, and seat the washer firmly against the jaw faces or the chuck body.

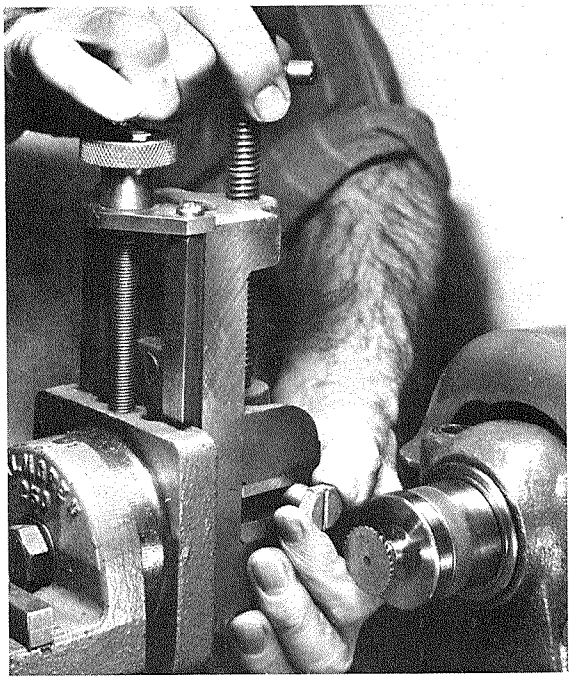
• *Machining break-away rings.* If you want to make two half-rings that fit together to form a reasonably perfect ring, you can make the cuts before doing the machining. Assemble the required number of individual, close-fitting parts into a blank that can be machined and then broken down into its original number of segments. Use an epoxy glue to fasten the parts together; to separate joints, apply force in a way that will not cause marring or other damage.



Your lathe can solve bolt problems

By WALTER E. BURTON

SETUP for milling slot in a hexhead bolt: The milling attachment holds the bolt and the collet holds the cutter.



SEE ALSO

Bolts . . . Fasteners . . . Metal-lathe accessories . . . Screws . . . Threading . . . Tools, hand . . . Wings, nut and bolt

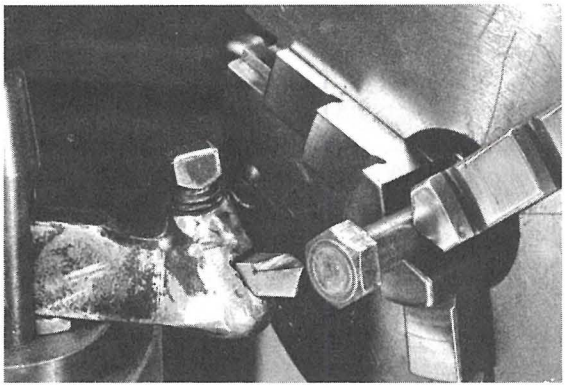
A GOOD FEATURE about a metal-working lathe is that it can be used as an emergency tool for turning out needed parts, such as particular types of bolts or screws. And in many cases a needed part can be modified from a similar, available part.

For example, it is not difficult to lathe-make a complete bolt, starting with a hexagonal or round steel bar. For a sizable bolt, the bar is typically mounted between centers. The body is turned to diameter with a portion of the bar left to form a hexhead or to be milled to hexagonal shape. Then the bolt is threaded. For small bolts, it may be convenient to hold the bar stock in a chuck and do the threading with a die.

In modifying existing bolts for special uses the lathe can be mighty useful. The photos show several such modifications. Others may suggest themselves, or, rather, be suggested by particular needs when an experimental machine is being built, or some other work is being done in which either special bolts or "normal" ones not in stock at the moment are needed.

Standard bolt heads often are too high to enter the T-slot in a machine-tool table or to be used in some other limited space. Here, the excess metal can be trimmed off with a rough-turning bit or a cutoff tool.

Sometimes it's desirable that a bolt with a



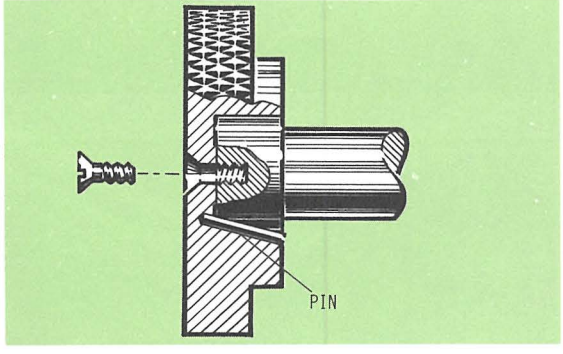
HEXHEAD BOLT is easily converted to a roundhead one. Here, the bolt is held in a three-jaw universal chuck.

square or hexhead can also be turned with a screwdriver. You can add a neat slot by clamping the bolt in a lathe milling attachment and mounting a suitable cutter (such as a slotting saw) in a headstock chuck or collet.

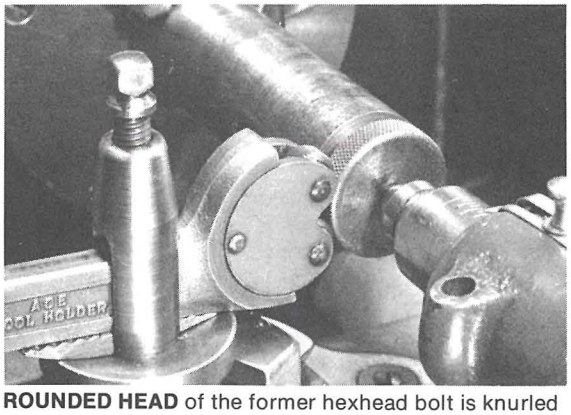
In other uses, it may be desirable to have a bolt with a round and knurled head so it can be turned readily with your fingers—a thumbscrew, in effect. Knurled, hollow-head capscrews are standard items, but not always at hand. For a small knurled head, the regular head of a bolt can easily be turned down and knurled.

To fill a hurried need for a shoulder bolt, a standard type can simply be mounted in a reasonably true-running chuck or between centers, and the threaded end turned to the desired diameter and rethreaded. The shoulder screw shown in the photos has a ⅜-in. body (or shoulder) dia., and a ¼-20 thread. It was made from a ⅜-in. hexhead bolt.

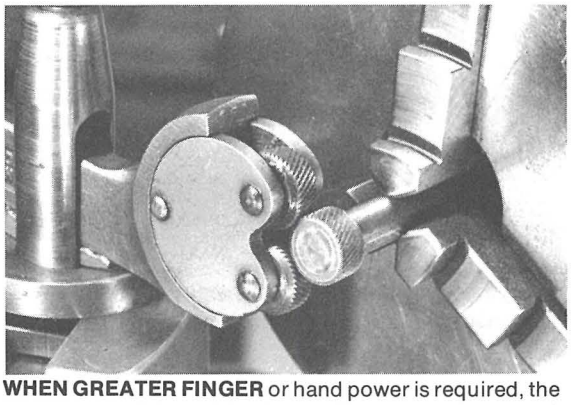
Making a special bolt on a lathe or modifying a standard one for some particular purpose may not be as romantic as machining the barrel for a model of a famous cannon, but this helpful ability of the metal shop's most versatile tool can save time and money.



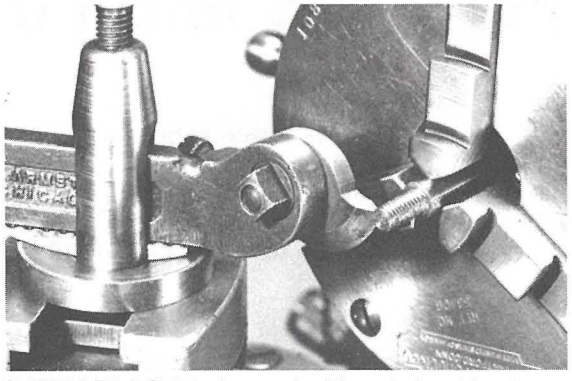
HEXHEAD BOLT is converted to a large knurled head type by steel crosspin.



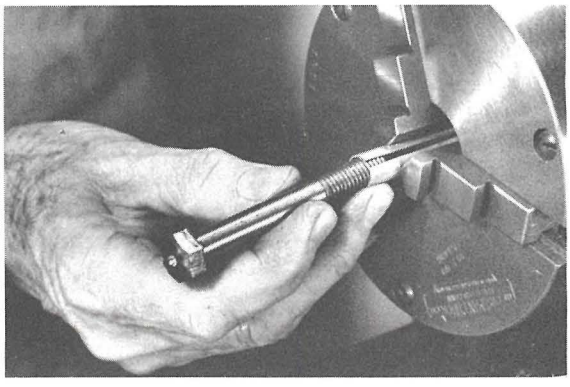
ROUNDED HEAD of the former hexhead bolt is knurled for easy finger-turning in its new application.



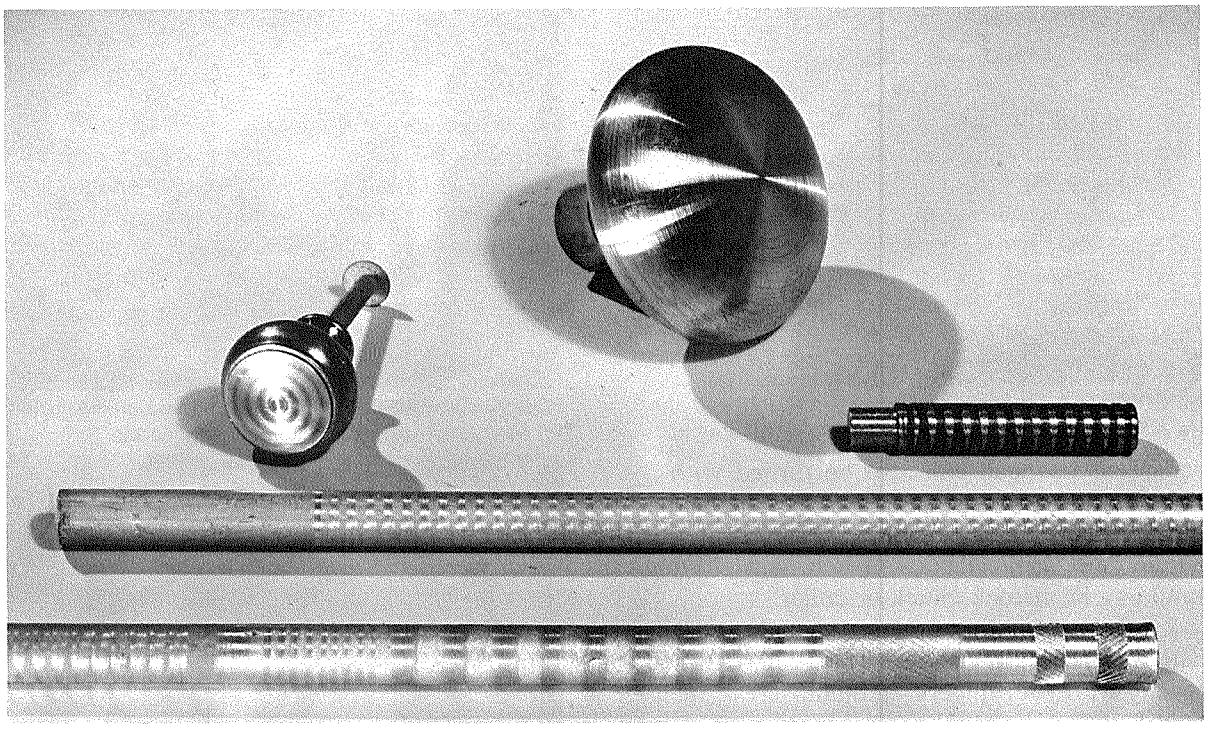
WHEN GREATER FINGER or hand power is required, the head can be fitted with a larger diameter knurled cap.



SHOULDER BOLT being made: Threaded end has been turned to a smaller diameter and is being rethreaded.



SOFT ALUMINUM SLEEVE is used to protect the bolt threads in chuck while the bolt head is center-drilled.



TYPICAL LATHE-PRODUCED FINISHES. Aluminum tubes were polished with abrasive rubber; their decorative bands were made with a knurler. Knobs were done with abrasive-rubber pencil or bit and abrasive cloth.

Put a fine finish on lathe projects

A craftsman's skill and patience are often judged by the appearance of his finished job. There are many ways of finishing a metal-lathe project. The secret is to choose the one that's right for yours. Here's a survey of some of the techniques available for your next project

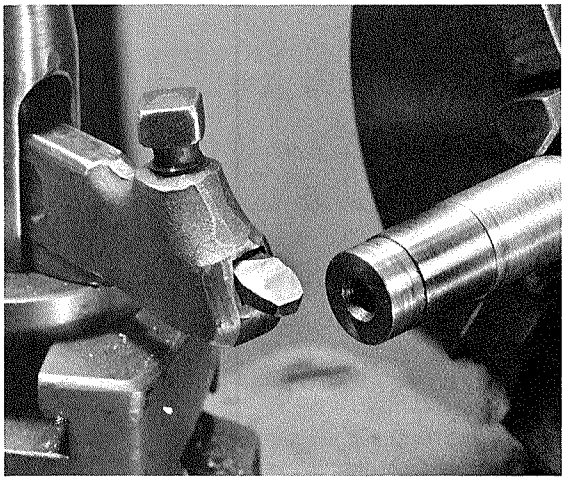
A COMPLETED SHOP PROJECT is generally rated by the appearance of its finish—the treatment applied to the surface to bring out its beauty and, perhaps, enhance its functional value. This can be particularly true when doing home shop lathe work on a model, a special tool or an instrument part.

There are so many ways of finishing turned metal that it's just about impossible to present them all in one article. But this abundance can be

SEE ALSO

Abrasives . . . Metal-lathe accessories . . . Sharpening, tool . . . Tools, hand

A SHARP TURNING TOOL used with a light touch produces smoothness. The lathe bit should have a rounded tip.



stimulating—it provides a lot of room for experimenting; you can enjoy the adventure of working out and trying other stunts on your own.

As a general rule, the type of finish to apply depends on the use to which the turned article is to be put. Roughly, some procedures can be grouped, as follows:

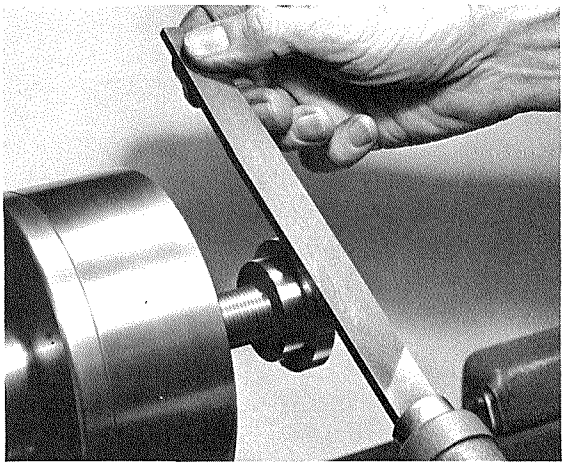
• *Turned finish.* For many purposes, as in making a punch for rough work, the finish left by the turning tool is good enough. A rounded tip is likely to produce a smoother finish-cut than a sharp, pointed tip. For the final, finishing pass, set the tool for a shallow cut and feed it very slowly along the work. Sulphurized oil or other lubricant may help. You'll find that the nature of the metal, as well as tool shape and sharpness, has a lot to do with the appearance of the turned surface.

Finish can be improved by using an oilstone (such as an Arkansas stone) to hone the cutting edge keen and smooth. *Tip*: If, when you attempt a very light cut, chatter develops and mars the turned surface, a switch to a lower spindle speed (even through back gears) may be a cure.

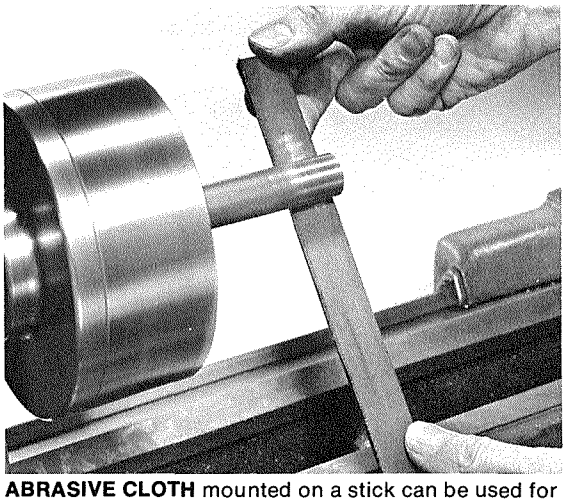
• *Filed finish.* When a turned surface isn't quite smooth enough, a bit of filing may be all that is needed. Although conventional files can be used on a lathe, steeper-toothed lathe files designed specifically for smoothing rotating work are better. Flat lathe files usually have untoothed edges. The work and file should be free of oil and other material, and the teeth kept clean by frequent brushing with a stiff wire brush. Bits of metal accumulating on and between file teeth can produce some unsightly grooves in the area being smoothed. Some mechanics rub a file with chalk to discourage chip pile-up. (When using a lathe file, take care to prevent fingers, sleeves and other parts of clothing from being snagged by the chuck, dog, or workpiece and always grip the file as if you are left-handed.)

• *Abrasive paper and cloth.* Coated abrasive materials include cloth and paper treated with aluminum oxide, silicon carbide, emery, crocus, or other abrasives such as grains or powders in various degrees of fineness. Grit size indicates the number of holes per inch in a sieve through which the grit will pass and may be expressed by that number, a fraction such as 4/0 or by an adjective such as "fine." You can use loose abrasive grit; there will be more on this later.

You often see emery cloth or paper recommended for polishing steel and other materials. (Emery, a natural variety of corundum, contains aluminum oxide and other minerals.) Probably

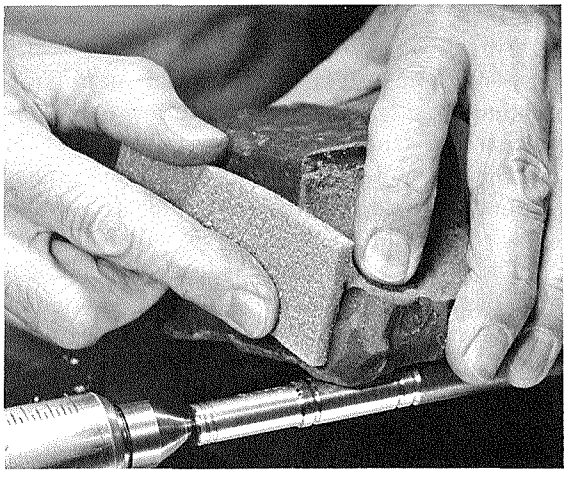


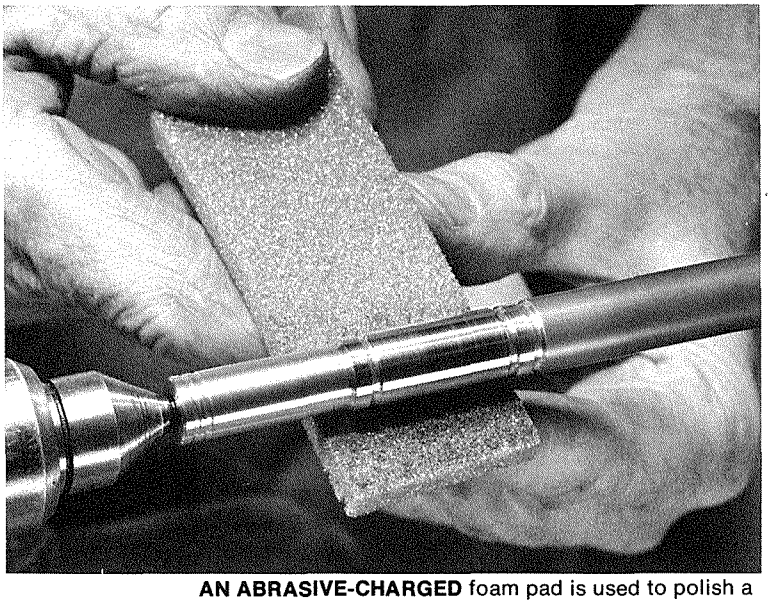
A FLAT FILE with its teeth cut at a sharper angle than a conventional file removes marks left by a turning tool.



ABRASIVE CLOTH mounted on a stick can be used for smoothing. Like a file, the abrasive should be kept moving.

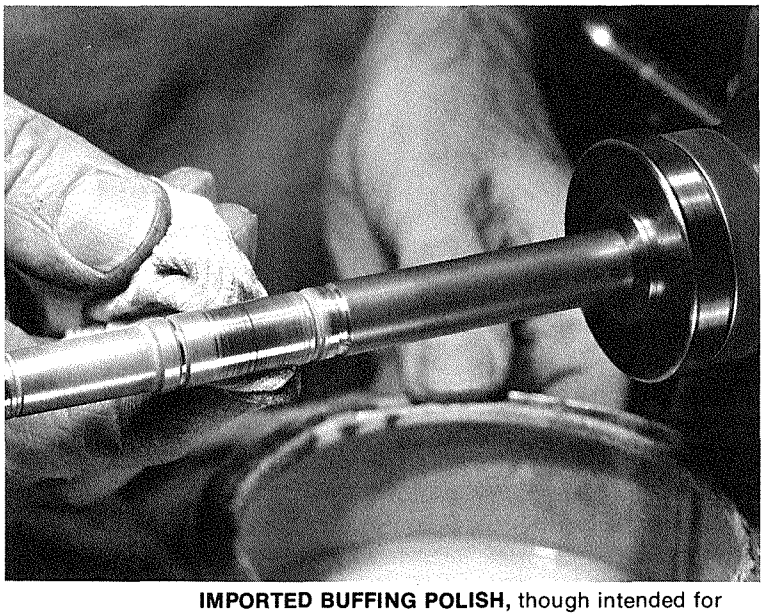
A RIGID plastic-foam block, rubbed over a cake of buffing compound, provides an adequate sheen, too.



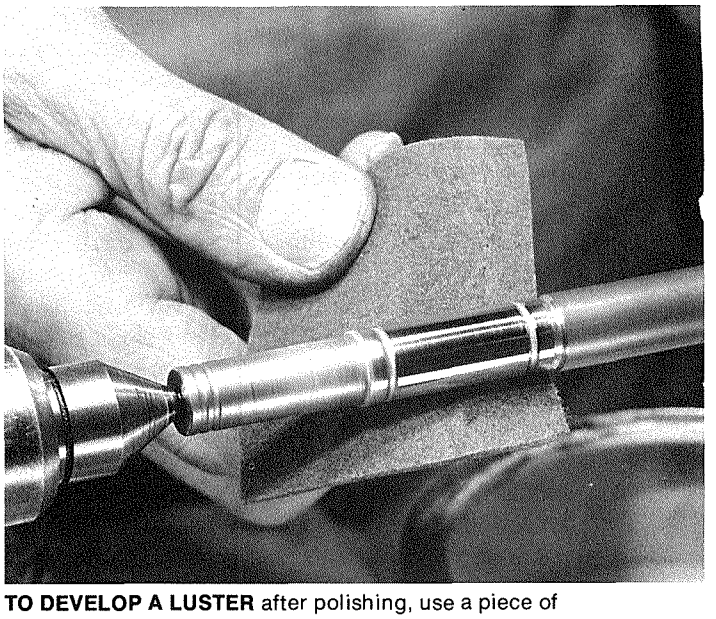


AN ABRASIVE-CHARGED foam pad is used to polish a brass rod after you smooth it with an abrasive cloth.

TIGHT GROOVES are polished with a flat stick charged with abrasive grit mixed with a light oil.



IMPORTED BUFFING POLISH, though intended for aluminum, works well on brass when applied with a cloth.



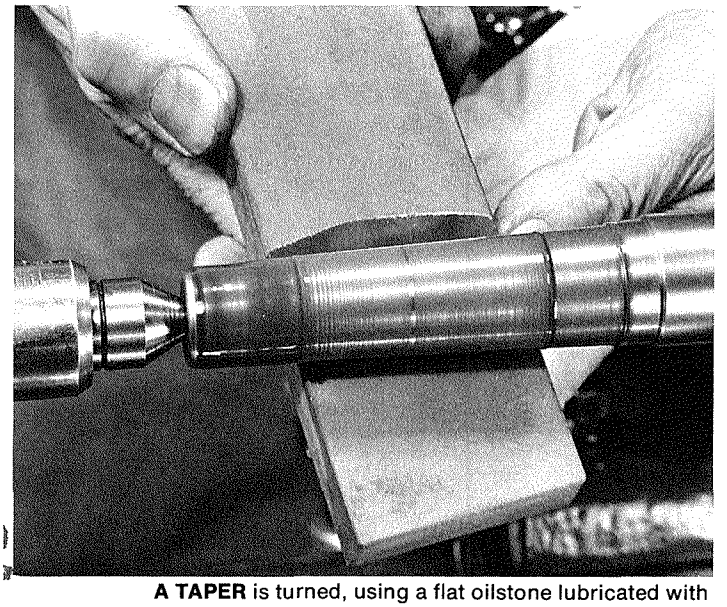
TO DEVELOP A LUSTER after polishing, use a piece of felt from an old hat to remove any dried compound.

some recommenders had in mind man-made aluminum oxide (such as Aloxite), or even silicon carbide (such as Carborundum) which is suitable for polishing hard, brittle materials. (Aluminum oxide seems preferable for tough steels and the like.)

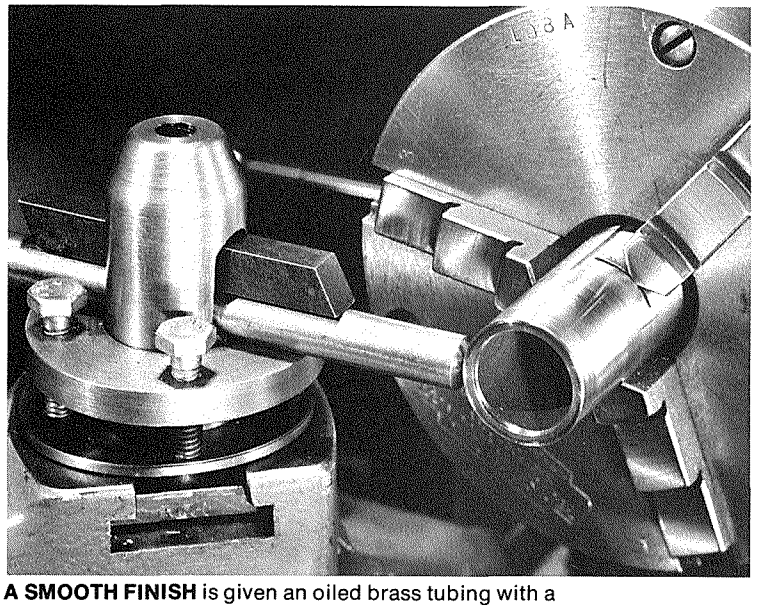
One polishing procedure is to glue or staple a strip of the abrasive-coated material to a flat wooden stick, and use it like a file—dry or sulphurized, or with machine oil as with an oilstone.

Whether abrasive cloth, paper or loose grit or powder is used to smooth turned work, the accepted sequence is to start with a certain size grit (for example, medium No. 150, or 4/0) and proceed by steps to finer and finer sizes. The first grit polishes out tool or file marks; subsequent grits remove scratches caused by the preceding, coarser grit. The second grit might be fine, No. 180 or 5/0, followed by extrafine, No. 220 or 6/0; and then finer polishing could be done with buffing compounds or commercial polishers. In the end, there may still be polishing scratches—but so fine they can't be seen without magnification.

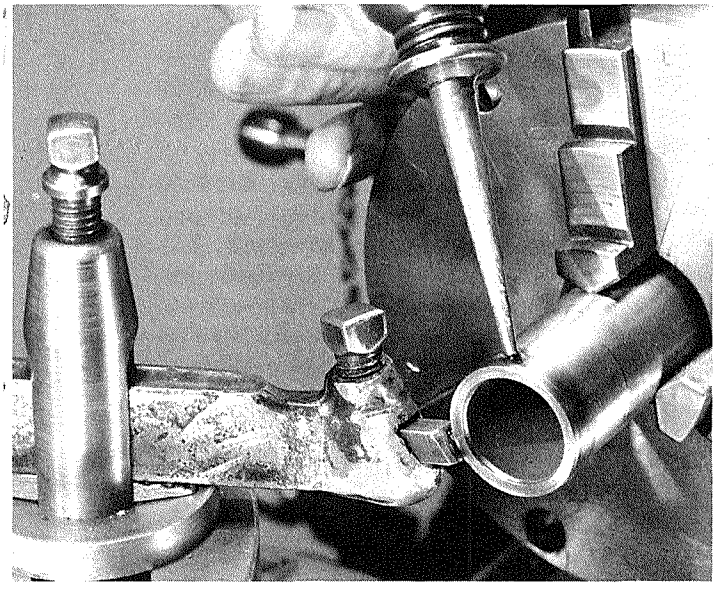
The precise grit sizes to use can be found by trial. Usually, in home-shop work, a sufficiently smooth surface can be developed in two or three



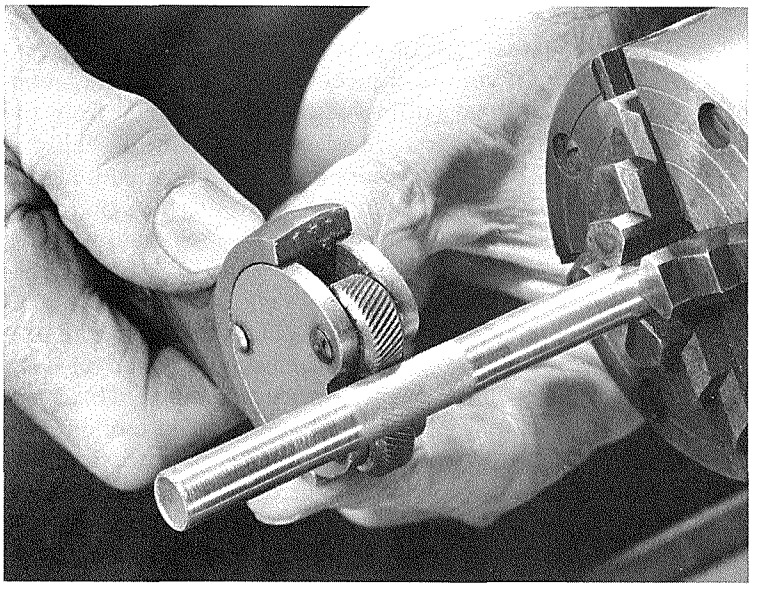
A TAPER is turned, using a flat oilstone lubricated with light oil. Move the oilstone in a back-and-forth motion.



A SMOOTH FINISH is given an oiled brass tubing with a diamond-tip grinding-wheel dresser used as a burnisher.



A HIGH-SPEED LATHE BIT can be used as a burnishing tool. Be sure that the work is kept well oiled.



A HAND-HELD KNURLING TOOL gives a fine, cross-hatched texture when held in the lathe.

polishing steps.

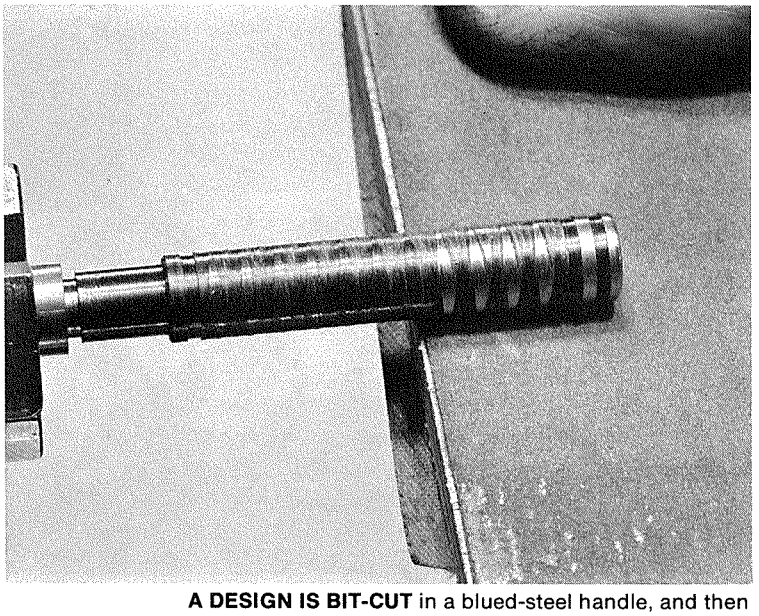
A worthwhile economy in the shop is to never throw away a piece of abrasive cloth that still holds together. The longer it's used, the finer it cuts; eventually it may produce a shine equal to that from the finest new material.

Instead of a stick to support the abrasive cloth or paper, you can shape various blocks, pads of felt, plastic foam, leather and the like to polish rounded shapes, including grooves.

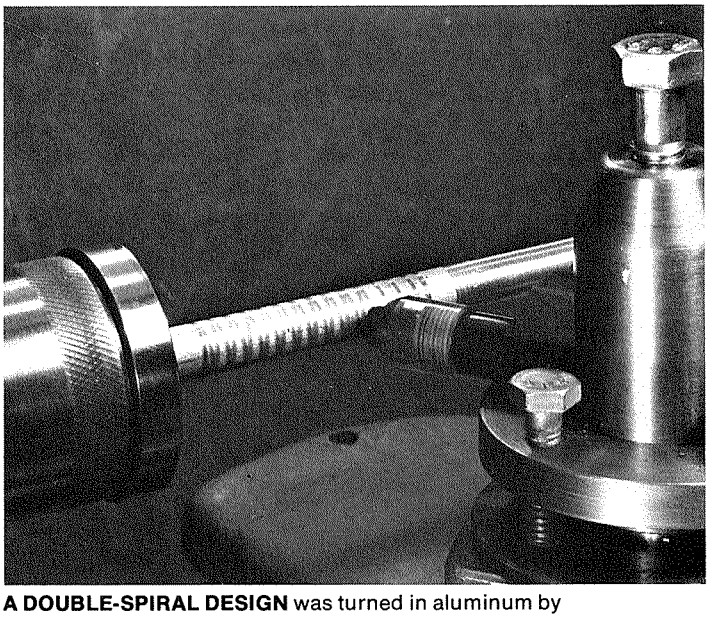
• *Buffing, honing, and burnishing.* Buffing removes flaws left by previous polishing. Buffing compounds usually consist of finely divided material mixed with a binder (dry powder in oil or other fluid). In normal lathe work, you probably would be more likely to buff brass, copper, aluminum or silver than steel.

A buffing compound designed for "cutting" is intended to be used first, followed by final buffing with a "coloring" preparation. Tripoli is a typical cutting material in buffing, while rouge (producing a burnishing rather than a cutting action) is used to bring out the final luster.

The buffing compound can be used on work spinning in a lathe by spreading it on a block or pad serving as the tool. The pad may be of



A DESIGN IS BIT-CUT in a blued-steel handle, and then polished with an abrasive cloth for a two-tone effect.



A DOUBLE-SPIRAL DESIGN was turned in aluminum by an abrasive-rubber pencil mounted as a "lathe tool."

leather, felt or plastic foam.

Of course, a piece can be polished on a conventional buffing wheel after removal from the lathe. Such a wheel, made of cloth or felt and charged with compound, might be mounted on a toolpost grinder and used to buff revolving work. Finally, buff with an uncharged wheel.

In oilstone lathe honing, an abrasive stone is held against the revolving work, primarily to grind down any metal points that might be projecting. Machine oil or special oilstone oil is the lubricant. The stone generally is moved back and forth parallel to the work axis, in circles or in figure-8s. "Superfinishing," a process attributed to David A. Wallace of the Chrysler Corp., is a form of honing with moving stones. Lathe headstock spindles operating in solid bearings are among parts on which superfinishing may be used.

Since a honed surface generally has a duller finish than a polished one, it can form a basis for subsequent polishing.

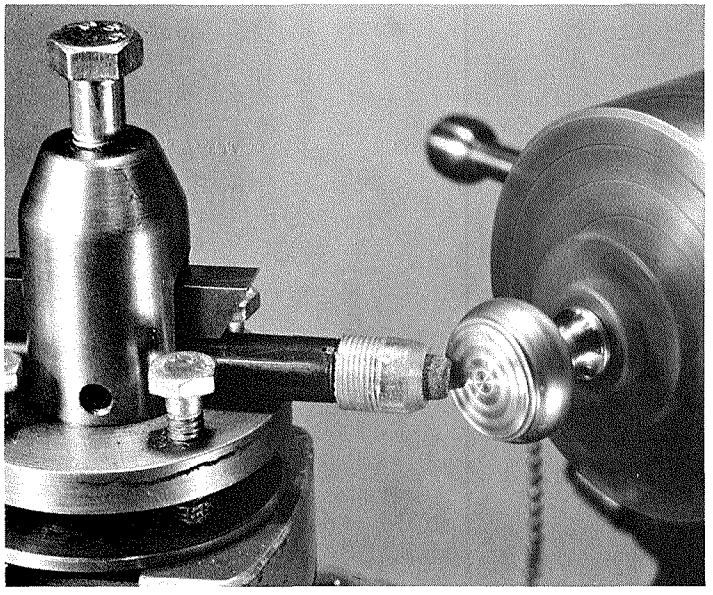
Lapping is an operation performed (often by hand rather than power) with abrasive grains plus oil or other fluid, to achieve close fitting of parts, bring gauges to precise size, even out surfaces and so on. Thus, you might lap a taper shank into a taper hole. Some lapping compounds are designed to break down readily to make their action self-limiting, and thus prevent "overlapping."

Lathe burnishing is simply a rubbing operation with a hard, highly polished tool pressed against the revolving, lubricated surface. Its desirability is best found by trial, for sometimes a similar smoothness can be produced readily by other methods. A sort of burnishing can be achieved with a diamond-point grinding-wheel dresser by adjusting it for light rubbing contact, employing fine feed and keeping the work well-oiled. But, some diamonds may prove too rough for a satisfactory result.

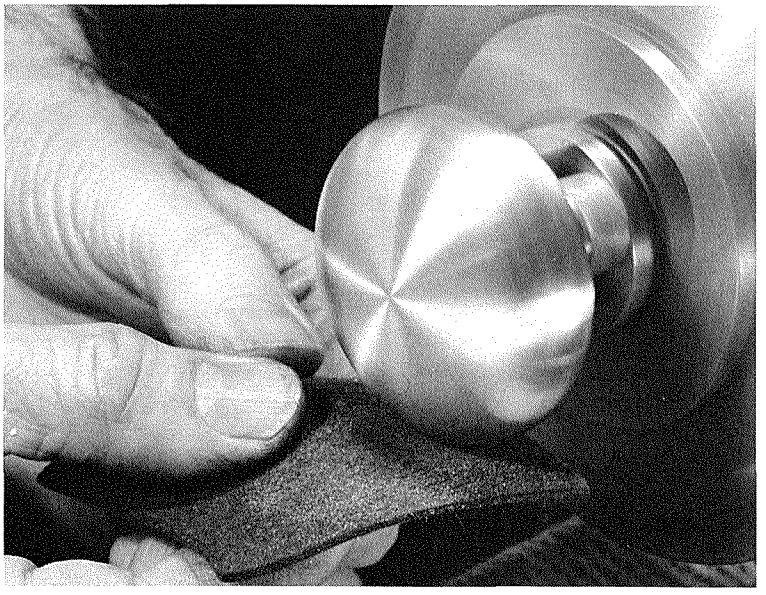
Sometimes the use of a commercial metal-polishing compound as a final finishing operation will develop on brass, aluminum, and the usual metals, a shine comparable to that achieved by wheelbuffing. Apply the polish to the spinning work with a small cloth or felt, manipulate the pad in contact for a while, then clean and polish with another cloth or felt. Always use a small cloth and check for roughness on the work that might snag it.

• *Texturing and "inlay" patterns.* Texturing consists of producing on the surface of turned work a pattern of lines or grooves that blend into a pleasing appearance. One way is to hand-hold a knurling tool lightly against the revolving work—preferably after polishing. Keep knurling pressure at a minimum, and frequently lift knurls from the surface and replace them, so they do not tend to follow a repeat path (as would occur in conventional knurling).

For metal tool handles and levers to be grasped, an interesting, nonskid effect can be produced by first knurling or cross-threading the surface, blueing the piece if it is steel or applying



DECORATIVE CONCENTRIC RINGS are also produced by rubber. Space rings with the aid of a cross-feed scale.



COUNTLESS CONCENTRIC SCRATCHES made with abrasive-charged cloth give a starlike light reflection.

colored lacquer if it is another metal, then filing and polishing it to remove color from the high spots while leaving it in depressions. Steel can be blued chemically or by heating until the desired oxide color develops.

• *Pattern polishing.* Selective polishing with an abrasive rubber eraser (or with Brightboy stick) can produce interesting effects. The surface to be decorated should not be highly polished, but preferably a dull finish such as that developing on aluminum over a period of time.

Spiral patterns on cylindrical work can be produced by mounting the abrasive pencil like a regular lathe tool and using a coarse-thread setting, such as 4 t.p.i. (threads per inch), to control tool movement. Tracing right and left-hand overlapping "threads" produces a lattice effect. A series of bright bands or rings can be made with abrasive hand-held or in the toolpost.

By mounting the abrasive pencil as you would a conventional bit for a facing operation, you can produce concentric circles, spirals, or lattice designs on the flat surfaces or knobs, push plates and other items.

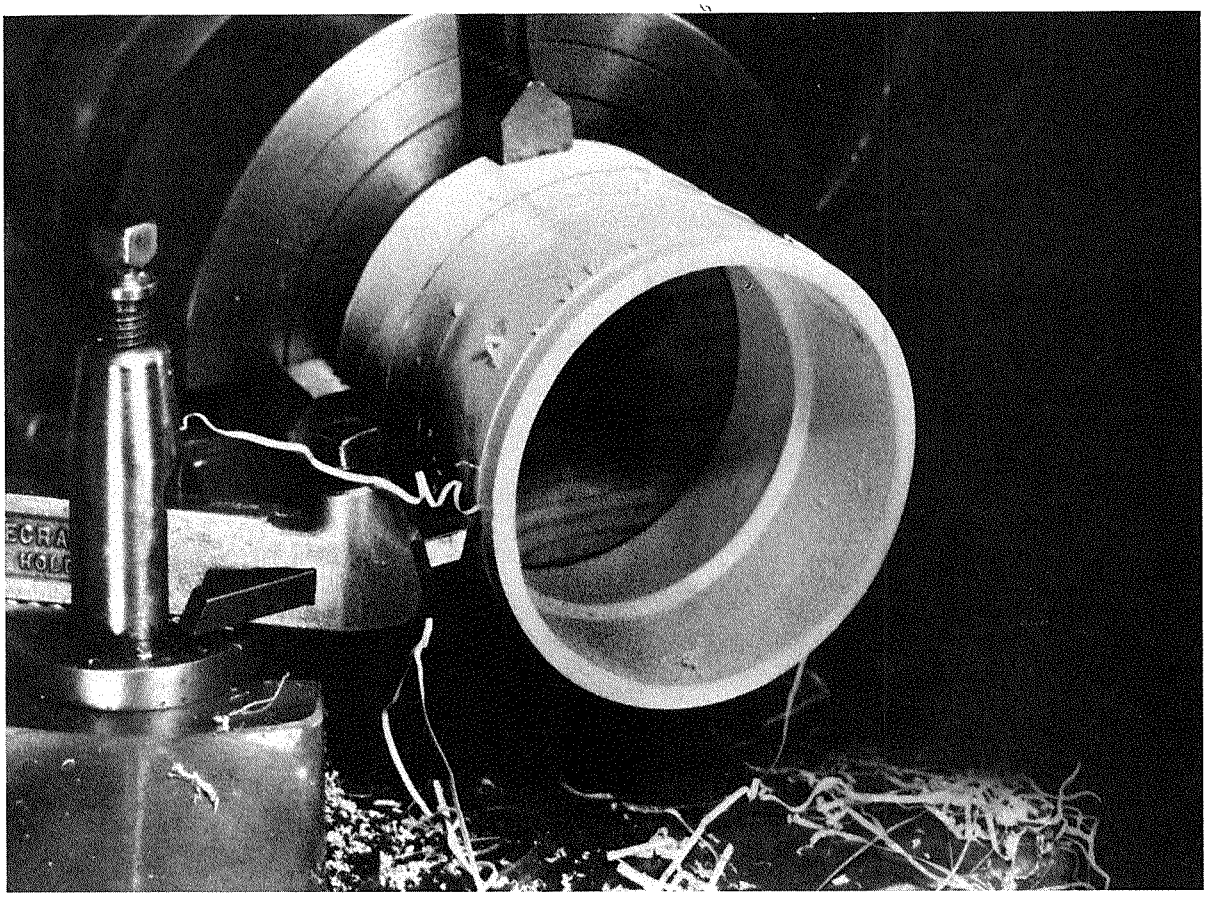
Those striking, circular-diffraction-grating-like effects you sometimes see on the front of transistor radios can be achieved on doorknobs, push plates and the like by mounting the item on a lathe faceplate or in a chuck and holding against it, as it spins, a fine-grit abrasive paper or cloth or a felt pad charged with fine abrasive powder.

• *Loose abrasive grits.* Almost any abrasive, if finely divided, can be used for polishing lathe work. It's fun to try different materials—such as aluminum oxide or silicon carbide grains and powders, pumice, Damascus ruby powder, rottenstone, valve-grinding compound, various abrasives used by rockhounds—and even household cleaning materials such as Bon Ami. Generally you can mix the abrasive with oil and use it to charge a pad or stick held against the spinning work. It's a good idea, when using any abrasive that could fall on the lathe, to cover the carriage and bed.

• *Grinding.* A toolpost grinder can produce a smooth finish on both hardened and unhardened metal. While grinding is often used primarily to bring the work to a definite dimension, or work metal too hard to cut with tool bits, the proper abrasive wheel can produce a very smooth finish. Recommendations for wheel choice can be obtained from suppliers of grinding materials and equipment.

There exists a considerable array of materials for producing smoothness and brightness, or achieving novel effects. In many cases, the best way to find out what is most suited for the job is to do some experimenting—to polish or treat some scrap pieces before tackling the main one.

Sources for various polishing and buffing supplies include William Dixon, Inc., Box 99, Newark, NJ 07101; also various abrasive manufacturers such as Norton Co., 50 New Bond St., Worcester, MA 01606 and the dealers who handle their products.



Turn plastic on your lathe

By WALTER E. BURTON

IF YOU'RE WEARY of turning steel and brass on your home-shop lathe, you can find diversion and challenge in working with an interesting nonmetal material—rigid PVC (polyvinyl chloride). It comes in various forms including sheet, pipe and fittings. In addition, there are other plastics rigid enough to be machined—such as acrylics (Plexiglas).

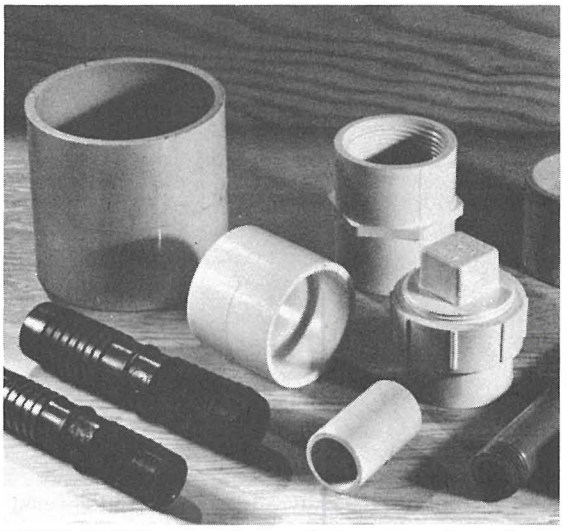
Shapes readily handled on the lathe, which can be used as good starting points in making various items, include pieces of rigid plastic pipe and such items as couplings, male and female adapters, cleanout plugs and fittings. Many local building-supply stores handle them, sometimes in a choice of colors such as white, gray, and ivory. Also, local distributors and fabricating shops often can provide sheet stock and scrap pieces of plastic materials they handle.

From such odds and ends, you can make various ornaments and novelties; even useful items such as washers and shade pulls. Or a trivet or trinket box (made from a Tepco fitting and plug) as shown in the drawing at right. The photos show a few lathe-turned items produced from random plastic parts (mostly of rigid PVC) found at local stores and in a shop scrapbox.

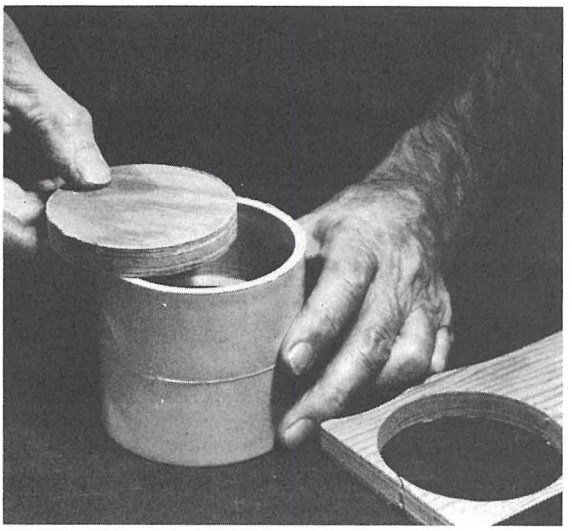
In production machining of rigid plastic materials, specially sharpened tools often are used. Some plastic compounds are so abrasive that tungsten-carbide tools are needed. But for limited machining of rigid PVC on a home-shop lathe, tools normally used for metals will do.

First, in turning plastics be sure that the workpiece is securely mounted in the lathe—that

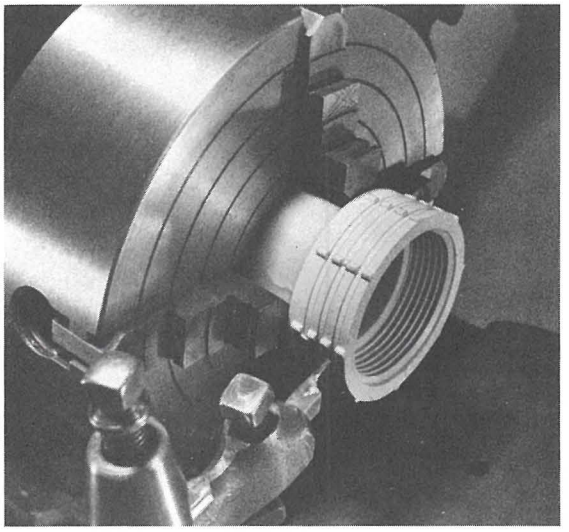
SEE ALSO
Metal-lathe accessories . . . Plexiglass projects . . . Tools, hand



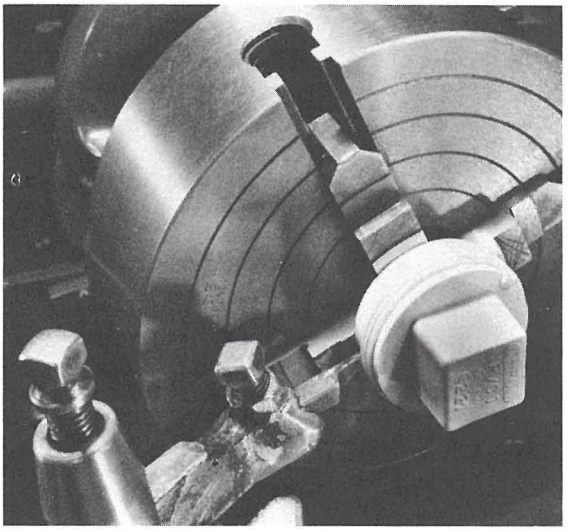
STOCK ITEMS are easily handled on lathe. Two black couplings in foreground fit plastic pipe.



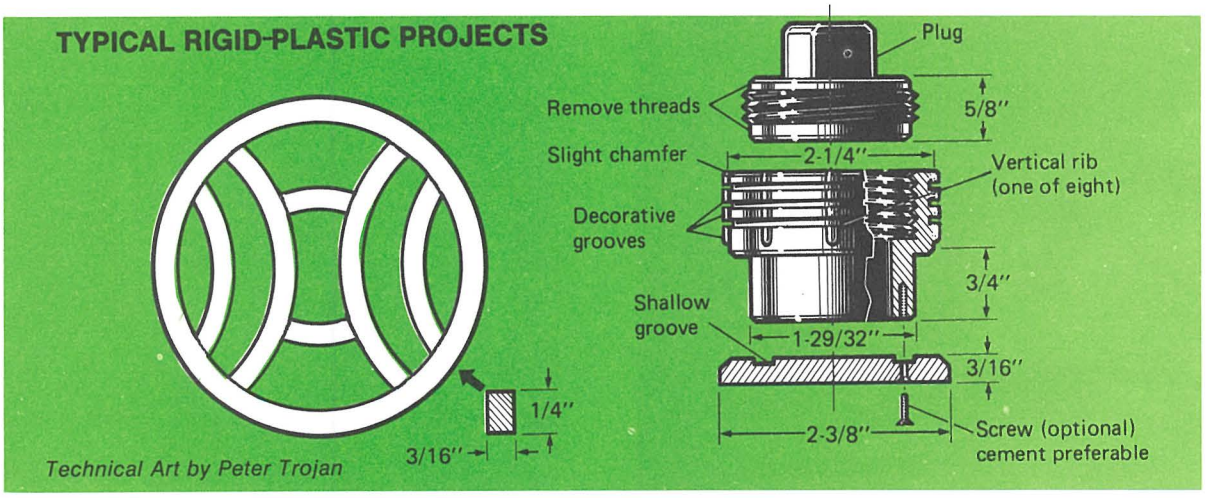
TO PREVENT WALLS from being crushed, simply cut a plug from ¾-in. plywood to fit pipe's i.d.

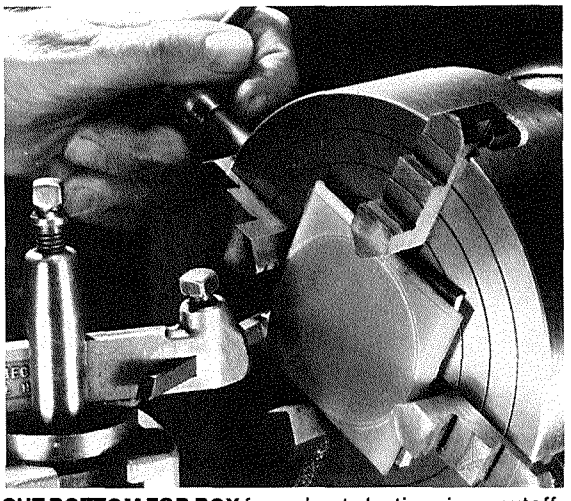


USE PARTING or grooving bit to cut decorative grooves in future jewel box.

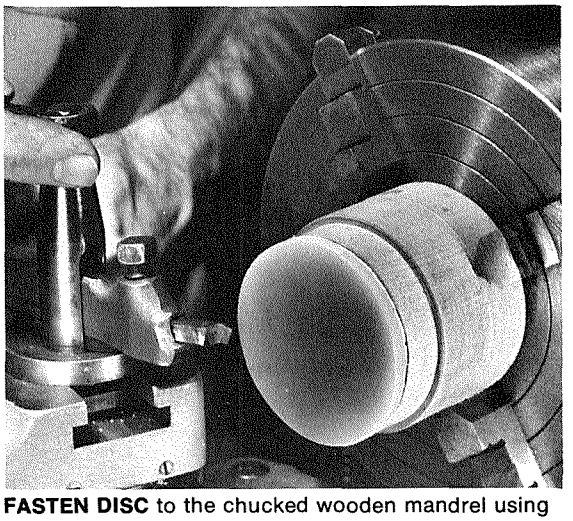


REMOVAL IS EASIER if all but a few turns of threads at top are machined off jewel-box cover.

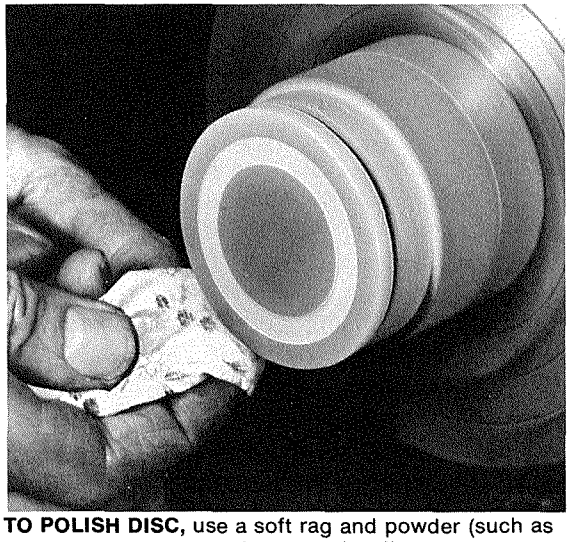




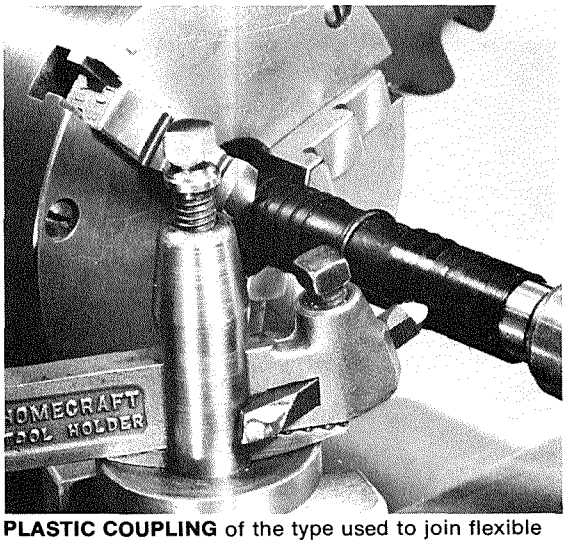
CUT BOTTOM FOR BOX from sheet plastic using a cutoff tool. Next, cut scrap away by hand.



FASTEN DISC to the chucked wooden mandrel using contact cement with a piece of paper between.

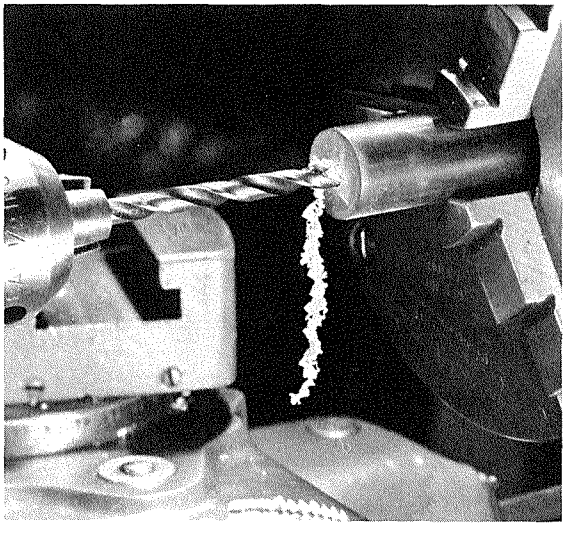


TO POLISH DISC, use a soft rag and powder (such as Bon Ami). Groove receives round wall.

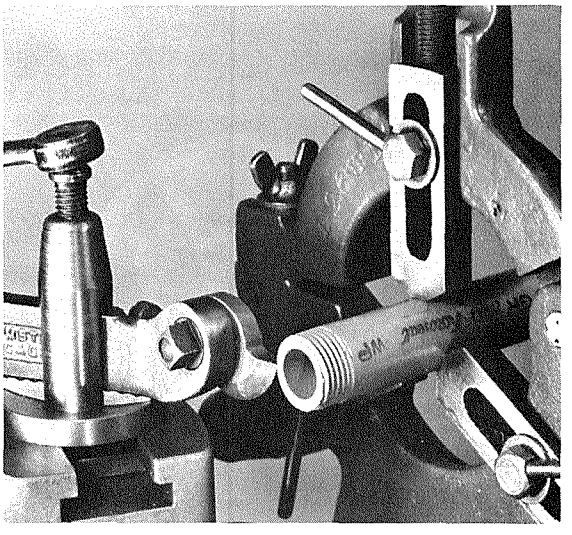


PLASTIC COUPLING of the type used to join flexible plastic pipe is soft but still machinable.

AS YOU DRILL HOLE in the end of the cast-resin rod, chips are almost white—though rod is amber color.



IN THREADING END of rigid PVC pipe, with aid of a center rest, use regular threading tool.



chuck jaws grip it firmly and that there is no unsupported overhang that is likely to cause trouble. Keep cutting tools sharp. Until you get the "feel" of the material and operation, it's good to use slow spindle speeds and a careful feed. Then judge whether you will gain by increasing speed and feed. Don't let chips accumulate.

In doing the work illustrated, ordinary lathe tools ground for machining brass and steel were used and worked well. Edges were kept keen by frequent honing. Tools generally were set with cutting edges in line with the workpiece center, as in threading. Those ground with zero or slightly negative rake and plenty of clearance seemed to work well in many cases.

In cutting the key-chain links with a thin-blade parting tool, the lathe was run at the lowest of its four direct (nonback-geared) spindle speeds. This produced free-flowing chips and a cut surface having a good finish that required little further treatment other than knocking off sharp edges.

Chips often come from the tool in long, uncurled ribbons and may collect in loose bunches which have to be cleared at intervals. Chips from any plastic accumulating on or near the lathe, should be removed frequently. Besides being messy, they might be a fire hazard. If the plastic produces a nose-irritating dust, use a breathing mask.

Some stringy chips may wind around the work, like thread on a spool, and have to be removed when they become a nuisance by obscuring the cut or tool. When rounding sharp edges with a file (single-cut files are preferred), a by-product may be very fine, clinging "whiskers." To rub them off, hold a piece of felt against the revolving work. All lathe work on the items in the photos was done without use of cutting fluid.

grip work carefully

Mounting work in lathe: Under chuck-jaw pressure, a tubular piece can distort so readily that it is impossible to get a firm bite on it. A remedy is to insert a wooden plug in the end gripped by the chuck. For a large diameter, this can be a disc of ½ to ¾-in. plywood jigsawed or turned to a light drive fit. For a small pipe or tube, a dowel may do. Rigid plastic materials can be marred by rough chuck (or vise) jaws; a layer or two of masking tape or other padding around the o.d. where the jaws will bite is advisable.

Unsupported projection of a workpiece from a chuck should be kept as small as feasible. For threading and other operations near the ends of somewhat long tubes, rods and pipe sections, a center rest with jaws as near the outer end as possible is a good bet. Tubes and pipe sections can be center-supported like rods if their i.d. is not greater than the diameter of the pointed portion of the center; or they can be plugged and mounted between centers, like metal rods. Centers are lubricated with oil.

Corners, edges and surfaces can be smoothed with fine abrasive sheet. The degree of polish obtainable is best found by tests on the material being worked. Some plastics will require more polishing to bring out a desirable sheen. Merely burnishing with a wooden stick or one charged with an abrasive may be sufficient; this is one way of smoothing bottoms of deep grooves and the like. Bon Ami powder on a cloth or felt pad will polish some plastics spinning in a lathe; it was used for the base of the trinket box shown. Other polishes, such as those for brass or aluminum, could be tried. It's fun to experiment on scrap with various abrasives.

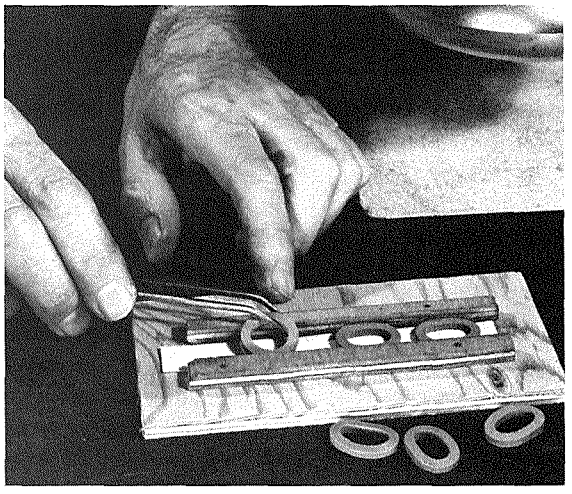
decorating plastic

Finished plastic can be decorated with paints or lacquers. Hobby shops usually carry paints for the plastic-model trade. A gold paint was used in the grooves turned on the trinket box.

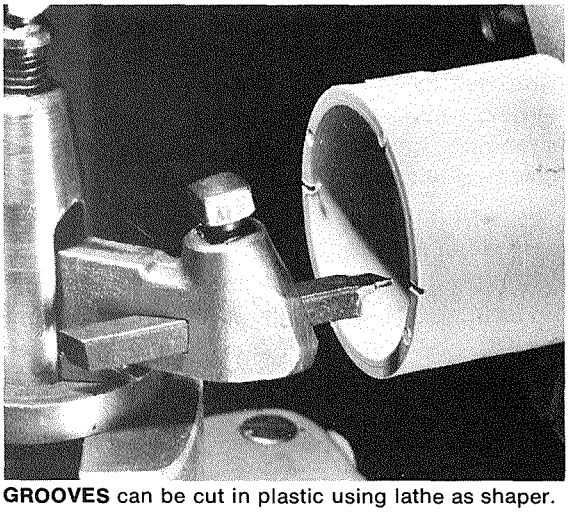
An attempt to knurl a rigid PVC pipe resulted in a shallow pattern consisting essentially of grooves in cross-hatch arrangement. The material tended to give under knurl pressure, and well-formed diamonds could not be produced. However, the resulting diamond-hatch of lines was attractive and could serve as a slip-resistant grip surface.

Off-the-lathe treatment of turned items may include cutting, drilling, boring, milling, filing, bending and cementing. In the home shop, rigid PVC can be worked successfully enough with ordinary on-hand, "nonlathe" tools intended for wood or metal. For hand-sawing, try a dovetail saw or small hacksaw; for splitting rings to make the key chain, a jeweler's saw is preferable.

Because rigid PVC is not a good thermal conductor, the frictional heat generated by drilling or another operation may build up rapidly in a tool. Drill bits and other cutters should be watched for signs of overheating. As suggested earlier, tools should be sharp so that they produce less friction. Plastics containing fillers dull edges rapidly. A drill bit may seem to cut easily and penetrate with little resistance, but it should

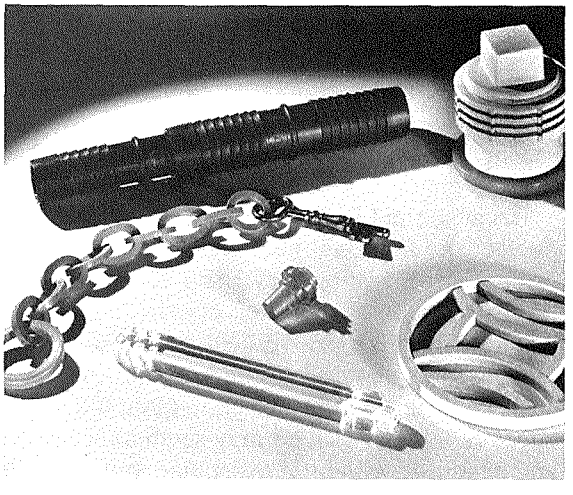


ELONGATED LINKS were formed by heating with lamp, then letting them cool between wood strips.



GROOVES can be cut in plastic using lathe as shaper. Here cross-slide is moved to and fro while side-mounted cutoff bit plows grooves in edge.

EXAMPLES of lathe-turned plastic: Black couplings were machined to slide together like telescope tube; trinket box was made from cleanout plug; oversize key chain is of two diameters of rigid pipe.



be withdrawn frequently, especially from a deep hole, for cooling and chip removal. Well-polished bit flutes offer less resistance.

For a threaded hole in a plastic material, you may use a slightly larger drill than for metal, to prevent excessive thread height. When there is a great deal of threading to be done, you may grind the tap (or die) teeth to a slightly negative front-angle rake.

If necessary, a plug can be installed to stiffen the wall of a pipe or tube for lathe-threading. Such threading may weaken the material; if the wall is thin, joining parts with cement generally is preferable. Suitable cements are sold by sources of rigid pipe and fittings.

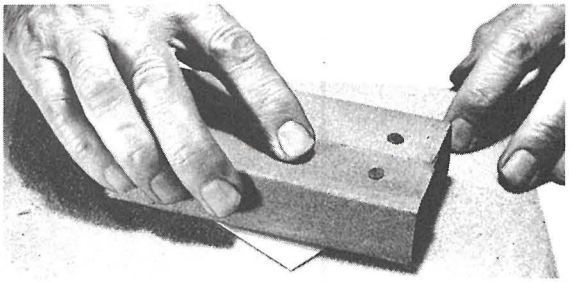
shaping with heat

Rigid PVC, a thermoplastic material, can be heat-softened. In its soft state, it can be bent, stretched or otherwise modified; upon returning to room temperature, it will be rigid again. For example, rings cut from a rigid Koroseal pipe for making the oversize key chain shown were softened by placing them a few inches from a 250-w. reflector heat lamp for a minute or so. Then they were made into elongated links by squeezing them between two parallel wooden strips. Alternate links were split with a jeweler's saw, snapped through adjacent links, and rejoined by cementing.

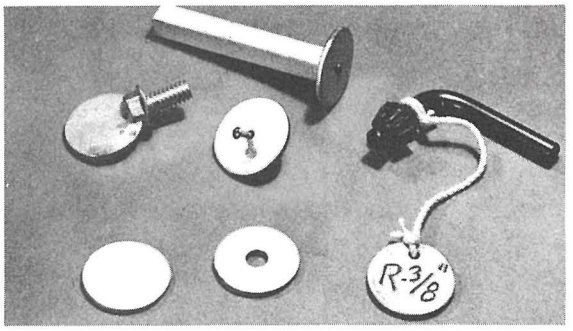
Softened PVC should be handled carefully so that its surface is not damaged; if cooled against a rough board it may show the embossed texture of the board surface.

Though rigid PVC was used mostly in the sample projects, other plastics can be worked on a lathe, among them cast or molded resins. Some tough, somewhat softer plastics, such as those used for couplings for bendable polyethylene pipe, can be machined, but you may have to guard against a tendency for them to bend too readily. PVC stock pieces may vary in properties; there are extra-rigid grades for severe service. When turning such materials, the lathe operator usually has little difficulty in detecting differences in their response to tool action.

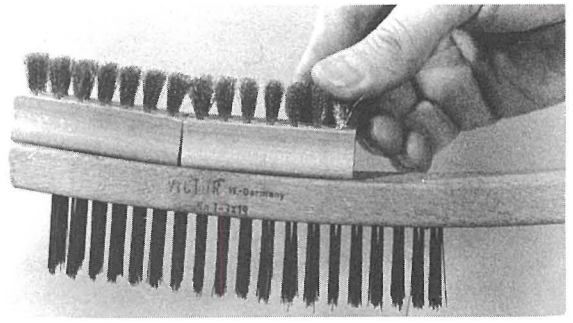
But whatever the particular piece of PVC or other plastic, it is interesting to determine what can be done with it on a lathe. The venture can be useful, for rigid plastic parts, besides being somewhat easier to obtain and easier to machine than metal ones, may have certain properties that no metal can boast—such as a desirable resistance to oils, grease, water, weather, as well as most chemicals likely to be encountered.



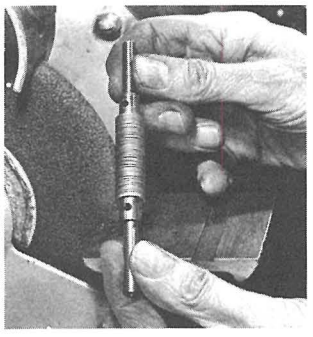
CARDBOARD SHIMS often need to be slightly reduced in thickness. An easy method I use is to place the cardboard on a sheet of sandpaper and rub it with a sandpaper-covered block of the same grit.—*B. W. Ervin, Kent, OH.*

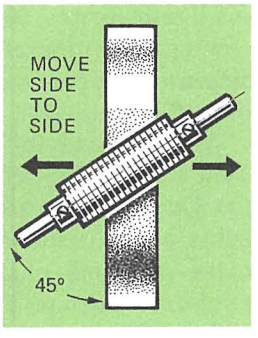


KNOCK-OUT DISCS from electrical boxes can frequently be put to emergency use in the home and shop. Four possibilities shown are wheels for toys, washers (after drilling holes), tags for drill-chuck keys and thumbscrews. For the latter, flatten the disc edge and simply solder the disc in a screw slot.—*W. B. May, Oak Park, IL.*

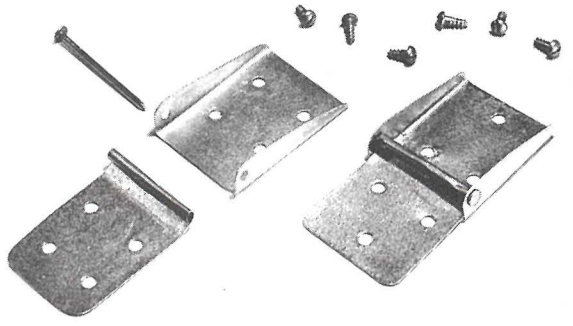


A STIFF WIRE BRUSH is a common item in the craftsman's toolbox, but for certain jobs the bristles are too coarse. Rather than buy another tool, I simply glued a pair of finer brushes—the type used for suede shoes work well—to the back of the wire brush, and then screwed them in tightly. The result was a dual-purpose, fine/coarse brush.—*Ken Patterson, Regina, Sask.*





GRINDING WASHERS of the same size in a hurry can be done by first slipping them on a rod with a flat ground on one side. Then, with washers held by means of two collars, grinding can proceed. Hold washers at an angle and move them back and forth across the wheel. They will spin as they are ground.—*Frank Rothmann, Anderson, SC.*



SURFACE HINGES can be quickly improvised from pieces of a tin can for those times when you need them right away and the stores are closed. Stock for one leaf is ½ in. wider than the other to allow for right-angle bends. To finish, drill mounting and hinge-pin holes, and then use a nail of appropriate size for the "hinge pin."—*Walter E. Burton, Akron, OH.*

Learning to live with the metric system

By ED NELSON

Will the conversion to metrics simplify—or complicate—our lives? Must we give up our miles-per-hour, our quarter-pounder sandwiches, and even our 10-gallon hats as we inch (centimeter?) along toward the metric system? Here's what you should know about the Big Switch—plus a wealth of easy-to-use tables that show you how to convert virtually any measurement to or from metrics

THE UNITED STATES is going metric. Many of us have heard that statement since childhood.

We've also been told that the metric system will simplify our lives.

Indeed, as this is written, there is a change underway—even though anti-metric pressure groups are fighting it bitterly. These traditionalists, who feel that any measurements good enough for their forefathers are good enough for them, have won skirmishes here and there. Their voices were loud enough to stop, at least temporarily, the conversion of highway signs from miles to kilometers. Members of Congress have been amazed at the bitterness of the opposition to the metric system.

But slowly and inexorably the United States is being "metricized." We now are buying soft drinks and liquors by the liter, weathermen are telling us the temperature in degrees Celsius, and the waist sizes of all our kids' Levis are stamped in centimeters as well as inches.

Will this conversion to metrics simplify our lives? Probably not as much as we've been led to believe, but there certainly are big advantages to the metric system. (Big disadvantages, too, holler the traditionalists.)

Just what is the metric system? Where did it come from? When? More important, why?

The metric system is a precisely defined body of weights and measures accepted by international authority.

SEE ALSO
Calipers . . . Measurements . . . Tools, hand

where they came from

It's quite correct to say that there have been several different metric systems, since some measurements have undergone a series of modifications. But for the most part these were only small refinements. Many of today's metric units aren't greatly different from the uniform units of measurement demanded by Talleyrand after the French Revolution.

Another name for metric units is "SI" units. That's the abbreviation bestowed on metrics by the General Conference on Weights and Measures, an international body that met for years to make revisions which for the most part were miniscule. Such revisions and simplifications finally were completed and accepted in 1960, and the entire body of measurements was named the *Systeme International d'Unites*. The conference decreed "SI" as the official abbreviation in all languages. (However, the U.S. Department of Commerce still prefers to call it the International Metric System.)

Throughout man's history, he has required familiar, consistent and easily available units of measurement. The Biblical *cubit* was the length of the forearm from the elbow to the end of the middle finger (in ancient Egypt that amounted to

approximately 20 of our modern inches). And consider the inch itself; our inch came from the early British measurement, which was defined as "the length of three barleycorns, round and dry."

forearms won't do

As man learned to master his environment and to build his machines, such imprecise measurements no longer served him adequately. Neither forearms nor barleycorns are uniform, and no system of measurements is useful unless the units mean the same thing to all who use them. In fact, confusion in regard to exact meaning can lead to chaos.

Furthermore, the standard to be agreed upon must be available to all who use it. The distance from the tip of King Henry's nose to the end of his thumb—the official basis for the English *yard*—may have been totally consistent all the time the King was on his throne, but few Englishmen had access to it.

The length of the *mile* has been elastic, too. Our word *mile* is a descendant of the Latin *milia passum*, or one thousand paces. The Roman *mile* had a very precise definition; it was one thousand paces measured from the point where the heel of one foot strikes the ground to the point where the same heel strikes the ground again. A precise definition all right, but a highly imprecise measurement. A Roman legionnaire built like Mickey Rooney would count off a good many more miles than one measuring up to Charlton Heston.

sailors and problems

Nautical miles, another oldtime measurement, have never had anything to do with paces. How can you walk on water? A *nautical mile* was defined as one minute of the Earth's circumference—1/21,600th of the way around the world. This, again, may appear to be a very precise measurement. And it *was* precise until it was discovered that the Earth isn't perfectly round, so a one-minute arc doesn't mean the same everywhere. As a result, the *nautical mile* has been redefined in feet; to be exact, a *nautical mile* measures 6076.1 feet.

Then along came aviation. Fliers use long-distance navigation methods developed by sea captains, but most early flying was done over land. As a result, U.S. aviators use both *statute* and *international nautical miles*. Sounds confusing, eh? However, so adaptable is the human brain that pilots and navigators quickly learn to convert, almost automatically, from one kind of mile to the other. No doubt aviators will be happy to settle, eventually, on the *kilometer*. However, this experience demonstrates how rapidly we can learn to shift from one measurement system to another, and do it without much difficulty when the need arises.

The metric system has had its share of ambiguities, too. In the 1700s the Paris Academy of Sciences thought it was pinning its basic unit of measurement—the meter—to one of nature's most constant realities; surveyors established the sea-level distance from the North Pole to the Equator, and the *meter* was defined as one 10-millionth of that length.

Ha! That, too, soon developed flaws. The average guy trying to measure the distance from the North Pole to the Equator, and then fractionate it, was no more successful than the English serf who sought to measure the distance from King Henry's nose to the end of his Royal Thumb.

decimal convenience

Disregarding the Royal Thumb, the metric system offers one tremendous advantage over any other system ever invented. It's the same advantage that the United States coinage system had, until recently, over most other coinage systems since the early days of the Republic. This major advantage is *the decimal relationship of one unit to another*. If you can multiply by 10, or 100, or 1000, you can easily manipulate the system.

This is most helpful to those of us who desperately try to avoid multiplication and division. In the metric system, in most cases, a specific unit is 10 times the size of the next smaller unit, and 1/10th the size of the next larger unit.

Take the measurement of land, for example. (We ordinarily are accustomed to measuring in *acres* or *square miles*—units which can have no logical relationship to one another.) In the metric system, the basic measurement of land area is the *are* (rhymes with bare). An *are* is defined as an area of land equivalent to a square measuring 10 meters on each side, or 100 square meters. A *hectare* (*hecto-* is a prefix signifying 100) is 100 times the area of an *are*, or 10,000 square meters. The system obviously lends itself to rapid mental

turn the page

calculation. Thus an area of 235 *square meters* is equivalent to 2.35 *are* and to .0235 hectare.

Compare that calculation with the arithmetic necessary to convert 4,367 square feet into square yards, square rods and acres!

Most other metric elements are just as regular in their decimal consistency. *Milli-* is the prefix for one one-thousandth, so a *milliliter* is a thousandth of a *liter*. This metric relationship is somewhat comparable to the number of cubic inches in a gallon in our customary system, except that there's no logic to our customary system. Well, how many cubic inches *are* there in a gallon? The answer is 231, but how many of us can be expected to know that, or even know how to compute it?

The relationship of cubic inches to gallons isn't the only example of our customary measuring units that fit together so clumsily they scarcely seem to fit at all.

a foot is a foot?

Take something as familiar as the *foot*. No, the foot isn't always the same throughout the United States, and in our technological society even minor differences can be critical. In the U.S. there are two slightly different "approved" definitions for the *foot*, and the British offer still a third "approved" definition. The American Standards Association (now the American National Standards Institute) stated that a foot is precisely 0.3048 meter. The National Bureau of Standards says the foot is precisely 1200/3937 meter (which in decimals is about 0.3048006096).

Until deciding to go metric, the British, with their usual aplomb, said the foot was precisely one-third of the Imperial *yard*, and then defined the *yard*. The result didn't match our own two clumsy feet.

The three different feet are close in size. Their relative lengths are in this ratio:

914,400:914,402:914,399

But why should there be any difference at all? Can't we all talk about a *foot*—or any other unit of measurement—and mean precisely the same thing?

whose quart counts?

Now take a look at the quart, which is one of the most familiar and comfortable old measurements we've known since we hit the refrigerator as kids. A *quart* measures volume, and it shouldn't matter whether that volume is filled with corn likker or corn flakes. So how much is a quart? A U.S. *liquid* quart is 57.75 cubic inches; our *dry* quart is 67.0062 cubic inches. There's a difference of 16 percent between the two.

In 1864 Great Britain, facing somewhat the same problem, consolidated a number of various-size quarts into one quart for all uses. It amounts to about 69.35 cubic inches—bigger than either of our quarts. Until recently, if you bought a quart of Irish whiskey in Great Britain you'd get considerably more to drink than if you bought a quart of Kentucky bourbon in the United States.

Even some writers are traditionalists, and thus are apprehensive about giving up the old measurements. Some of us, observing the march toward metrics, feel a chill 11-centimeter hand squeezing our hearts. What will happen to our cherished figures of speech? Instead of saying, "Give him an inch and he'll take a mile," will we now be stammering, "Give him a centimeter and he'll take a kilometer?" Or, more precisely, "Give him 2.54 centimeters and he'll take 1.60934 kilometers?" Horrors! Have the metricians become morticians? Are they burying our language?

(Actually, John Heywood's original remark in the early 1500s was, "For when I gave you an inch, you took an ell." The ell was a cloth measure; in England it equalled 45 inches—or thereabouts. Old John didn't even mention miles.)

914-mm pin-up girls

Will we be ogling the girl whose millimeter measurements approach the metric ideal of 914-610-914? (No, that's not her phone number; it's her mathematical description.)

Will we be trying to shed 4.761 kilograms by living on a daily diet of 4200 joules? Will we have centimeter worms instead of inchworms, will our sailors be forced to give up their beloved knots, and will we ask at the fruit stand for 8.810 liters of apples, instead of the beloved and old-fashioned peck? As columnist Erma Brombeck asks, will we be saying, "Peter Piper picked a hectoliter of pickled peppers?"

Instead of walking "a million miles for one of your smiles" will we hike 1,609,300 kilometers for the same reward?

Are 10-gallon hats gone forever?

Levity aside, we *are* going metric. Many observers felt it would be much more difficult to get industry to accept metrics than to persuade the public. In many respects, the reverse has been

HOW TO CONVERT ALMOST ANYTHING TO—OR FROM—METRIC

Here are the factors to use in converting customary units to SI and *vice versa.* Most are approximate. To convert British nautical miles to meters, for example, a *precise* answer calls for you to multiply by 1853.184. But multiplying by 1850 would introduce an error of only about 17/100 of 1 percent. So our "approximate" factors still give you good, solid conversion figures.

This is how you use the table:

In starting with terms from the first column, multiply by the conversion factor in the second to find the equivalent in the SI units from the third column. Follow the arrows in the opposite direction to change from an SI quantity to its equivalent in customary units.

To make it easier to read long decimals, we follow the American National Standards Institute suggestion. We put digits in groups of three separated by spaces.

Multiply→ / To get←	→by→ / ←by←	→To get / ←Multiply
ACCELERATION		
feet per second per second	→.304 8→ / ←3.281←	meters per second per second
feet per second per second	→.109 7→ / ←9.113←	kilometers per hour per second
inches per second	→.025 4→	meters per second
per second	←39.37←	per second
miles per hour per second	→1.609→ / ←.621 4←	kilometers per hour per second
AREA		
acres	→.4047→ / ←2.471←	hectares
square feet	→.092 9→ / ←10.76←	square meters
square inches	→6.452→ / ←.155 0←	square centimeters
square miles	→2.59→ / ←.386 1←	square kilometers
square yards	→.836 1→ / ←1.196←	square meters

FORCE

SI units use kilograms only as units of mass ("weight" in popular usage). Force has a basic SI unit of its own, the *newton,* based on the force of inertia, not the force of gravity. One newton is the force that, if applied to a free body of 1 kilogram mass, will accelerate it at a rate of 1 meter per second each second. A newton, in customary terms, equals about 3.7 ounces of force.

kilograms force	→9.807→ / ←.110 3←	newtons
ounces (avoirdupois) force	→.278 0→ / ←3.702←	newtons
pounds (avoirdupois) force	→4.448→ / ←.225 1←	newtons

true. The change of highway signs to kilometers was attempted at a speed that the American people didn't find comfortable. There had been no consistent campaign to inform the public before kilometer signs suddenly appeared wherever the motorist was driving. The public hollered, and the government backed off.

Nearly half of the nation's thousand largest companies, on the other hand, are converting their specs to the metric system, or are inching (centimetering?) toward it.

A change in industry can be much more precisely planned. For example, leading torque wrench manufacturers, such as Sturtevant, have added metric calibrations to their wrenches (although instruction manuals still use customary units). Manufacturers use a special blue background for metric dials. Many users now accept newton-meters as the units they use, while others still choose pounds-feet (or less properly, foot-pounds) because they've lived with that unit all their measuring life.

ounces of turmoil

Now we plunge into an area of confusion. We have had a tendency in the past to use a single measuring unit for a variety of purposes. An *ounce,* for example, has been our unit for measuring troy weight, for measuring avoirdupois weight, and for measuring liquids. Yet these measuring systems are basically incompatible. The units are called *ounces,* but they're far from equal. We have used *pounds* for weight, and *foot-pounds* for energy—a combination of terms born of our assumption that the force of gravity is uniformly constant. Confusion!

Since the force of gravity *isn't* uniformly constant, the two measuring systems really require different terms. The *kilogram* thus becomes the

turn the page

HOW TO CONVERT ALMOST ANYTHING TO—OR FROM—METRIC

ENERGY (including Work)

The *joule* is the SI unit of energy or work. It is the work done (or energy expended) when a 1-newton force displaces a body for 1 meter in the direction of the force.

British thermal units (mean)	→1055← ←.000 948 7←	joules
calories (mean)	→4.190← ←.238 7←	joules
ergs	→1 x 10^{-7}→ ←1,000,000←	joules
foot-pounds	→1.356← ←.738←	joules
kilowatt hours	→3,600,000→ ←.000 000 277 8←	joules

LENGTH

caliber	→.025 4→ ←39.37←	millimeters
chain (surveyor's)*	→20.12→ ←.049 71←	meters
chain (engineer's)*	→30.48→ ←.032 81←	meters
inches	→25.4→ ←.039 37←	centimeters
mils (.001 inch)	→25.4→ ←.039 37←	microns (.001 mm)
miles (U.S. nautical)	→1.852→ ←.54←	kilometers
miles (U.S. statute)	→1.609→ ←.621 4←	kilometers
rods	→5.029→ ←.198 8←	meters
yards	→.914 4→ ←1.094←	meters

* A surveyor's chain, 66 feet, equals four 16½-foot rods or 100 7.92-inch links. An engineer's chain equals 100 12-inch links.

MASS (Weight)

carats	→.2→ ←5←	grams
grains	→.064 79→ ←15.43←	grams
ounces (avoirdupois)	→28.35→ ←.035 27←	grams
ounces (troy or apothecary)	→31.10→ ←.032 15←	grams
pounds (avoirdupois)	→.453 6→ ←2.205←	kilograms
short tons (2000 pounds)	→.907 2→ ←.068 52←	kilograms

POWER

Btu (thermochemical) per hour	→.292 9→ ←3.414←	watts
calories (thermochemical) per hour	→4.184→ ←.239 0←	watts
ergs per second	→.000 000 1→ ←10,000,000←	watts
foot-pounds (force) per second	→1.356→ ←.737 6←	watts

metric system, continued

metric unit for measuring mass (scientists prefer the term "mass" to "weight"). And the *newton* thus becomes a unit for measuring force—the force needed to overcome inertia and accelerate a one-kilogram mass to a speed one meter per second in one second.

But even in industry there has been some confusion. Sturtevant officials find many a purchasing agent unfamiliar with the distinction in measuring terms. Orders come in calling for torque wrenches calibrated in meter-kilograms, instead of newton meters.

conversion success story

For an area of change with a slightly different history, take a look at the pharmaceutical industry. Early in the 1960s, major drug companies opted for metric measurements. They moved fast, and even the public found the switch surprisingly painless.

Early on, manufacturers decided to change only what was necessary. Since the pharmaceutical industry deals mainly with weights and volumes, there was little concern about length measurements (inches or meters). Most of the processing machinery was amenable to change; scales, for example, could get by with only a new dial, new weights, or a new beam. Volume measuring gear took somewhat more modification, but still was not too difficult to alter.

Retraining workers turned out to be relatively easy; it went more rapidly than expected.

What about customers? At first, the metric quantities were added to the labels in parentheses after the customary quantities. Later, the metric quantity was printed first, followed by the customary quantity in parentheses.

The whole process went surprisingly fast. One of the largest pharmaceutical firms switched completely to metrics in about one year, and a spokesman says it could have been done even faster.

horsepower (550 foot-pounds per second)	→.745 7→ ←1.341←	kilowatts

PRESSURE

The pascal (Pa), adopted as the special name for a unit of pressure, is a newton of force per square meter. (See Force for a discussion of the newton.)

atmospheres	→101,325→ ←.000 009 869←	pascals
kilograms per square centimeter	→66.5→ ←.000 010 2←	pascals
pounds per square foot	→47.88→ ←.020 89←	pascals
pounds per square inch	→6894.75→ ←.000 145←	pascals

SPEED

feet per minute	→.005 08→ ←196.9←	meters per second
feet per second	→.304 8→ ←3.281←	meters per second
knots (international)	→1.852→ ←.539 96←	kilometers per hour
miles (U.S. statute) per hour	→1.609→ ←.621 4←	kilometers per hour
miles (U.S. statute) per minute	→94.41→ ←.010 59←	kilometers per hour

TORQUE

ounce-inches	→.007 062→ ←141.6←	newton meters
pound-feet	→1.356→ ←.737 6←	newton meters
pound-inches	→.113→ ←8.851←	newton meters

VOLUME

acre-feet	→1233.→ ←.000 810 7←	cubic meters
bushels (U.S.)	→.035 24→ ←28.38←	cubic meters
cords	→3.624 5→ ←.275 9←	cubic meters
cubic feet	→.028 32→ ←35.31←	cubic meters
cubic inches	→16.39→ ←.061 02←	cubic centimeters
cubic inches	→.016 39→ ←61.02←	liters
cubic yards	→.764 6→ ←1.308←	cubic meters
gallons (U.S. dry)	→4.405→ ←.227←	liters
gallons (U.S. liquid)	→3.785→ ←.226 4←	liters
ounces (U.S. fluid)	→29.57→ ←.033 81←	milliliters
ounces (U.S. fluid)	→.029 57→ ←33.81←	liters
pecks (U.S.)	→8.81→ ←.113 5←	liters
quarts (U.S. dry)	→1.101→ ←.908 1←	liters
quarts (U.S. dry)	→1101→ ←.000 908 1←	milliliters
quarts (U.S. liquid)	→.9464→ ←1.057←	liters
quarts (U.S. liquid)	→946.4→ ←.001 057←	milliliters

By the mid-1970s, food packages were working well into the first of these same two steps—printing metric measurements on the label after customary measurements.

Detroit moves fast

Car builders were joining the parade in earnest. A Chevrolet service bulletin on weatherstripping calls for "additional cement . . . down each side and around the lower corners approximately 152 mm (6 inches)." In regard to trunk locks, assembly mechanics were told, "Torque the attaching bolts to 10-14 Nm." At that point they weren't even told that this meant about 7.4 to 10.3 pounds-feet.

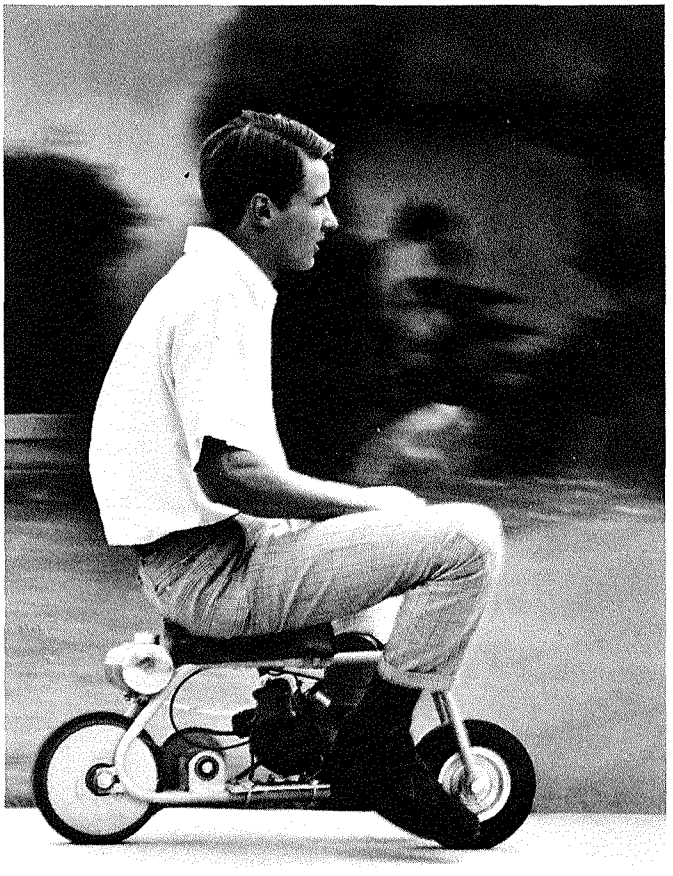
So now we're smack in the middle of metrics.

Regardless of how you feel about it, the wait for metrics has been a long one. 'Way back in 1821 John Quincy Adams told Congress that metrics offered "the ideal perfection of uniformity applied to weights and measures." But he added that the time wasn't yet ripe in the United States to adopt the decimal system. It has ripened very slowly.

while we hung back

The rest of the world moved steadily toward metrics while we, clinging to our feet and yards, our ounces and pounds, our pints and gallons, were left alone among the great industrialized countries. As this is written, the list of countries *not* committed to metrics is unimposing, as far as industry goes: Barbados, Burma, Gambia, Ghana, Jamaica, Liberia, Muscat and Oman, Nauru, Sierra Leone, Southern Yemen, Tonga and Trinidad.

It seems inevitable that metrics eventually will become universal. But it's likely that in 1999 we'll still bet on horse races measured in furlongs, McDonald's may still be featuring a quarter-pounder rather than a 0.113398 kilogrammer, Erskine Caldwell's classic will not have been renamed *God's Little 0.4047 Hectare*, and the announcer at the Superbowl will not be saying, "First down and 9.144 meters to go."



Build a Tom Thumb mini-bike

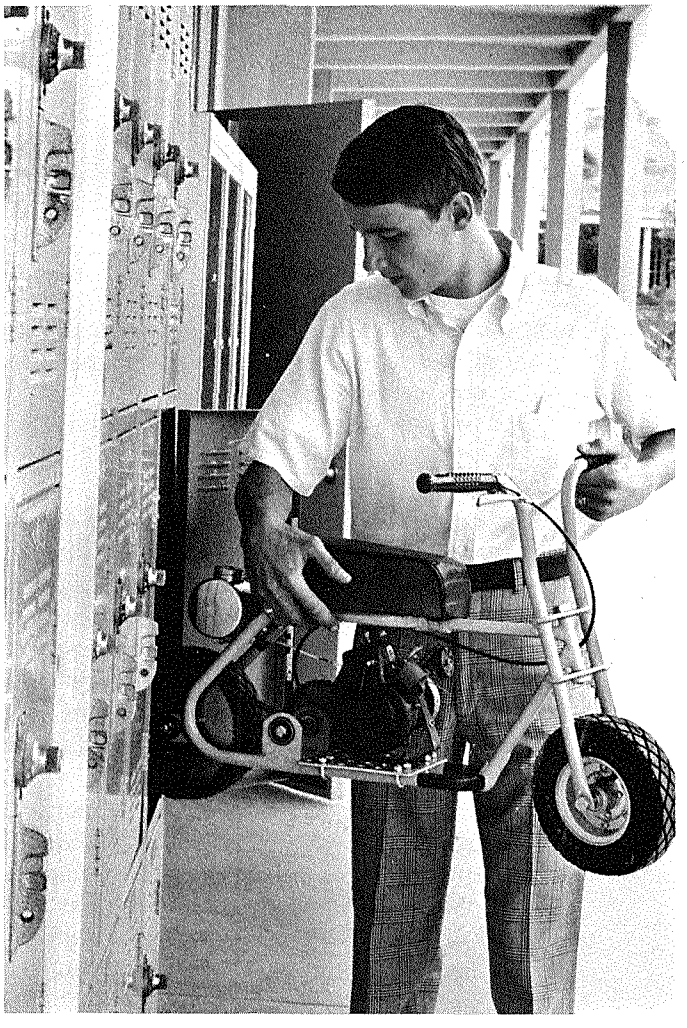
By GENE SCHATZLEIN

This vest-pocket, 2-foot-long motorbike will zip along at 11 mph. It is small enough to be stored in a school locker or in the trunk of a Volkswagen

THOUGH IT WILL NEVER CHALLENGE its bigger, more powerful, commercially produced cousins, this shop-built micro mini-bike will get you where you want to go for peanuts. Putting along—powered by its ¾-hp powerplant—the rig hits a racy 11 mph when flat out—more than enough to get you out on that backwoods jaunt or—with modification for street use—to class, football practice or part-time jobs with time to spare.

I used a ¾-hp Olson and Rice engine (now manufactured as O&R) mounted on a ⅛-in. sheet of aluminum. The aluminum sheet in turn is attached to the frame with four 4¼-in. U-bolts. (The bolts permit quick adjustment of the chain tension.) Depending upon the rider's bulk, the little bike may or may not take a steep hill. On occasion I've had to dismount and tote her up a hill under my arm.

BIKE-BUILDER Schatzlein shows how it is possible to fit his mini-bike into a school locker.



SEE ALSO
Bicycles . . . Fire engines . . . Motorcycles

The beauty of the bike is the practicality of its size. It gives me comfortable, efficient commutation to and from school, and there's no parking problem. I simply chain it to a parking meter or telephone pole.

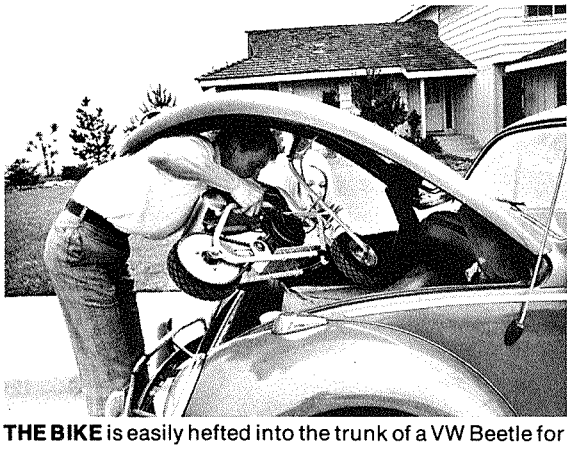
To make it, you'll need at least 12 to 15 ft. of ⅝-in. thinwall tubing for the frame. Build the frame in two sections and, for strength, join them with ⅝-in. steel pins inserted in the tubing at the joints. Where the pins cannot be used, wrap steel bands around the frame and braze for added strength.

The brackets which support the rear wheel are bent into a U-shape, slipped into the frame and brazed. The handlebars are two pieces of the thinwall tubing joined in the middle with two pieces of metal ⅛ x 1½ x 5 in. spaced 3¼ in. apart. The latter are drilled out at center to receive the ⅝ x 4½-in. bolt which serves as the turning spindle. To receive the front axle, the ends of the forks are flattened and drilled. To complete the front fork, bend the upper portions to form the handlebars. For leg clearance, bend forks slightly forward.

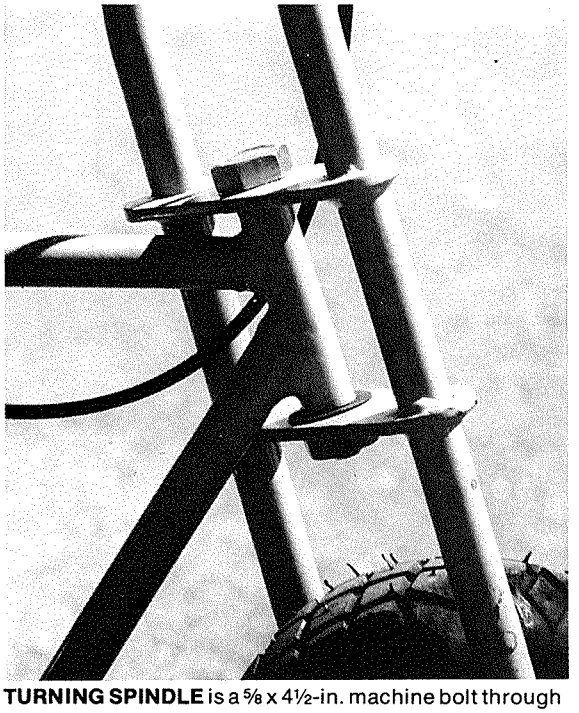
I used a Fairbanks-Morse centrifugal clutch with an inside diameter of ½ in. Thus, I had to use a ⅝-in. adapter to install the clutch on the engine.

The drive is provided by a No. 35 link chain. The engine sprocket has 11 teeth geared to the large sprocket on the 36-tooth jackshaft. Turning on the other end of the jackshaft is a 10-tooth sprocket geared to the 60-tooth sprocket on the rear wheel. This setup makes up a 20-to-1 gear ratio.

The baby-carriage-size wheels are four-inchers fitted with pneumatic tires and ½-in. bearings. Mount the gas tank on the frame stiffener—the

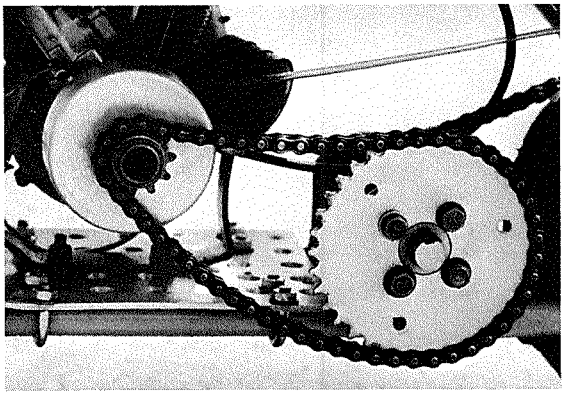


THE BIKE is easily hefted into the trunk of a VW Beetle for hauling to a meeting of minibikers.

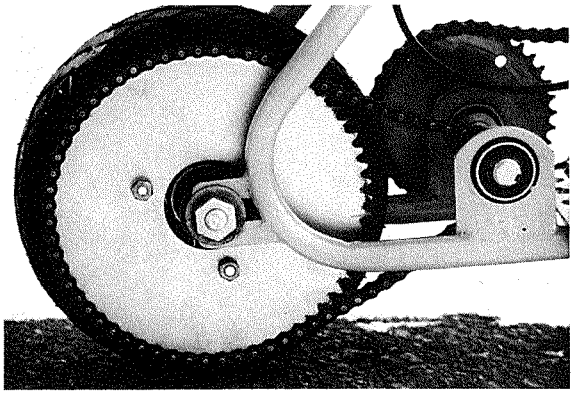


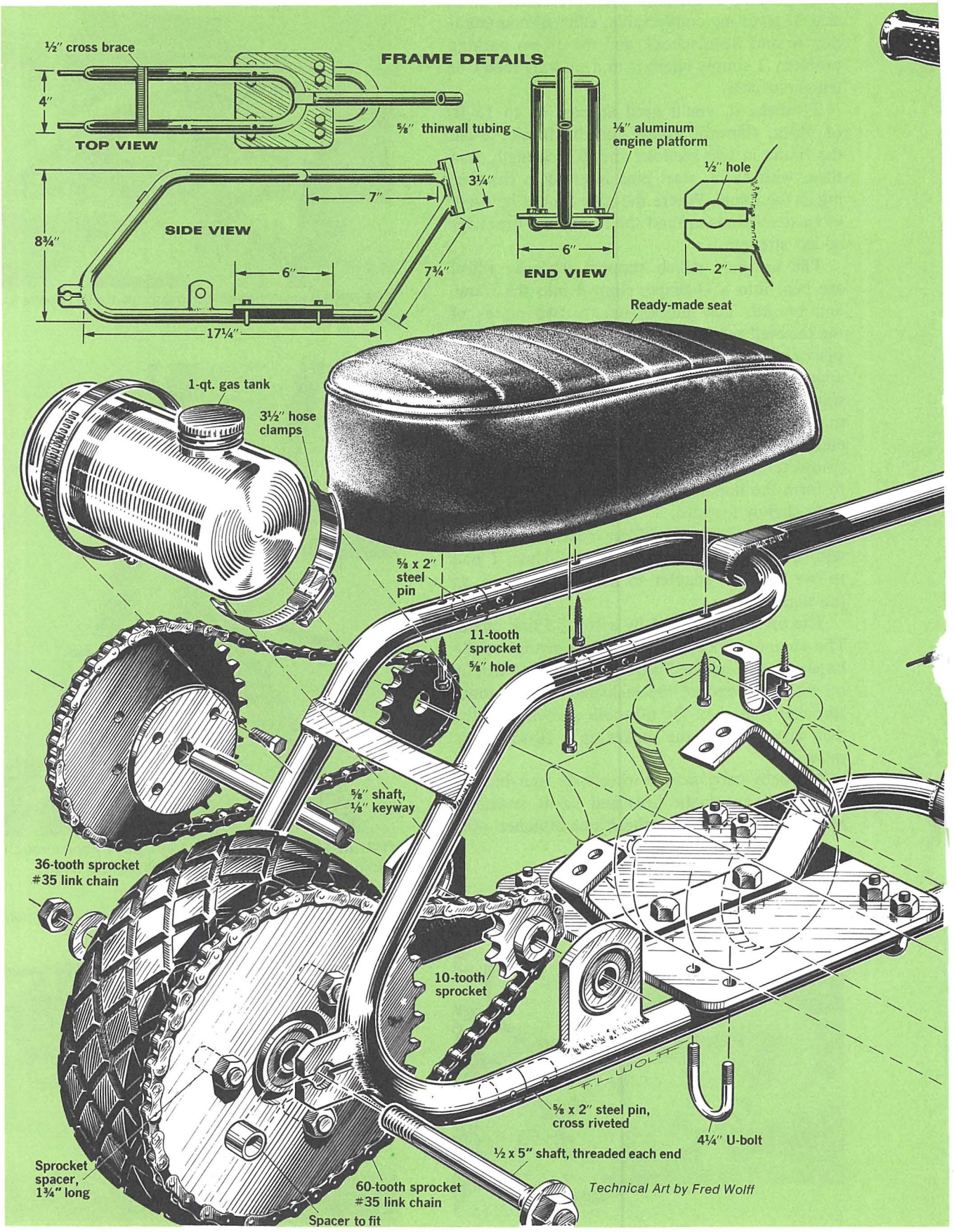
TURNING SPINDLE is a ⅝ x 4½-in. machine bolt through frame, on which two-piece handlebars turn freely.

SPROCKETS are set up to provide a 20 to 1 gear ratio. All parts for the bike were bought locally.



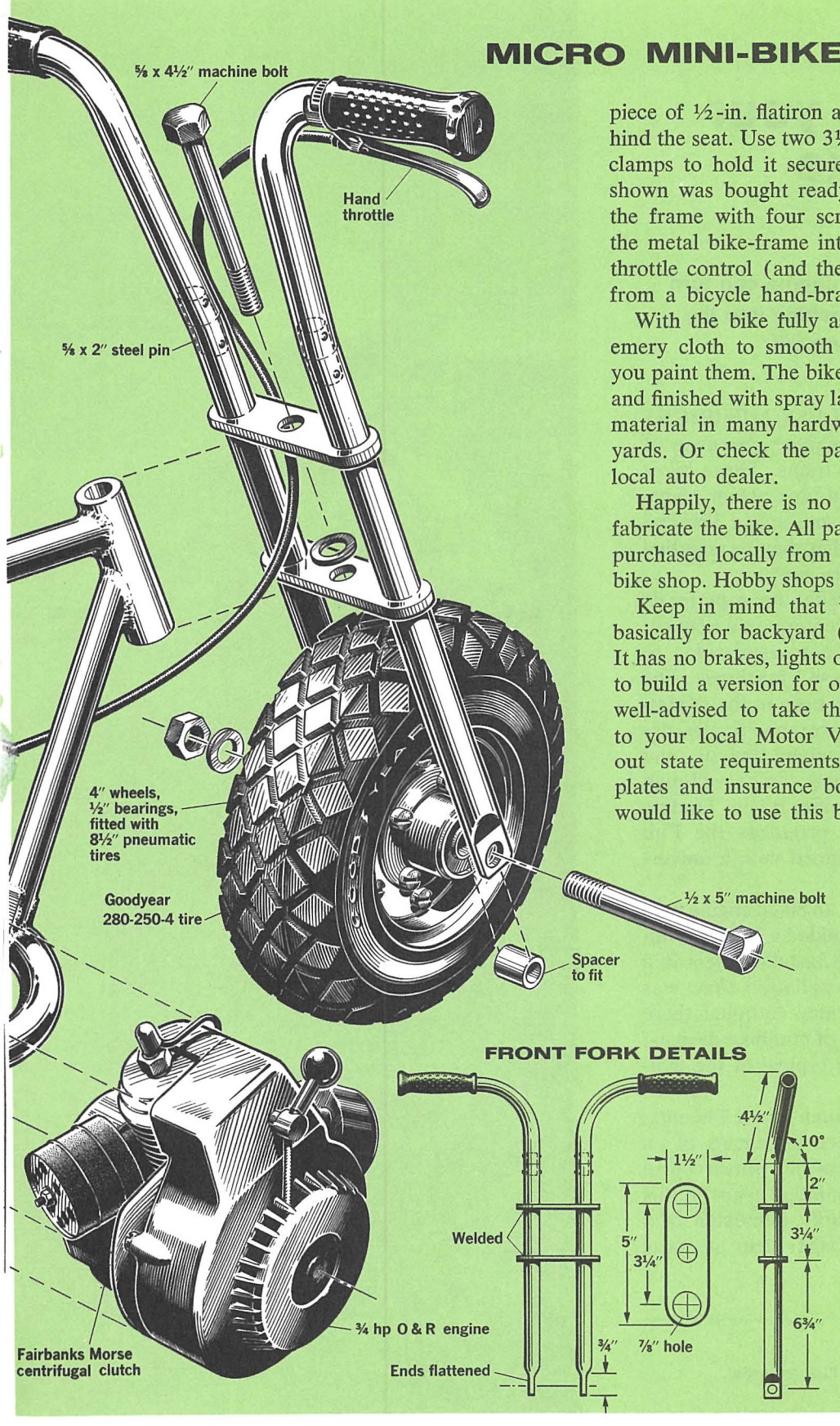
FITTINGS that hold rear axle are bent into U-shape, then are brazed onto frame for added strength.





Technical Art by Fred Wolff

MICRO MINI-BIKE


⅝ x 4½" machine bolt
Hand throttle
⅝ x 2" steel pin
4" wheels, ½" bearings, fitted with 8½" pneumatic tires
Goodyear 280-250-4 tire
½ x 5" machine bolt
Spacer to fit
¾ hp O & R engine
Fairbanks Morse centrifugal clutch

piece of ½-in. flatiron across the frame just behind the seat. Use two 3½-in. stainless steel hose clamps to hold it secure. The seat on the bike shown was bought ready-made and fastened to the frame with four screws turned up through the metal bike-frame into its wooden base. The throttle control (and the cable) were fabricated from a bicycle hand-brake control.

With the bike fully assembled, use a file and emery cloth to smooth all brazed parts before you paint them. The bike shown here was primed and finished with spray lacquer. You can buy this material in many hardware stores and lumberyards. Or check the parts department at your local auto dealer.

Happily, there is no hunting for materials to fabricate the bike. All parts for my machine were purchased locally from a lawnmower and minibike shop. Hobby shops often carry them, too.

Keep in mind that this vehicle is designed basically for backyard (on your property) fun. It has no brakes, lights or horn. Should you want to build a version for on-the-street use, you are well-advised to take the construction drawings to your local Motor Vehicle Bureau to check out state requirements for licensing. License plates and insurance both are necessary if you would like to use this bike in traffic.

FRONT FORK DETAILS

Modernize your old minibike

By DOUG RICHMOND

A new motorcycle engine can turn that worn-out, garden-variety machine into the hottest bike in the neighborhood!

THERE ARE COUNTLESS MINIBIKES sitting in basements and garages because of wornout engines or power trains. These bikes are equipped with industrial-type power plants and torque-converter transmissions. They've caused so many problems that they're regarded as more trouble than they're worth.

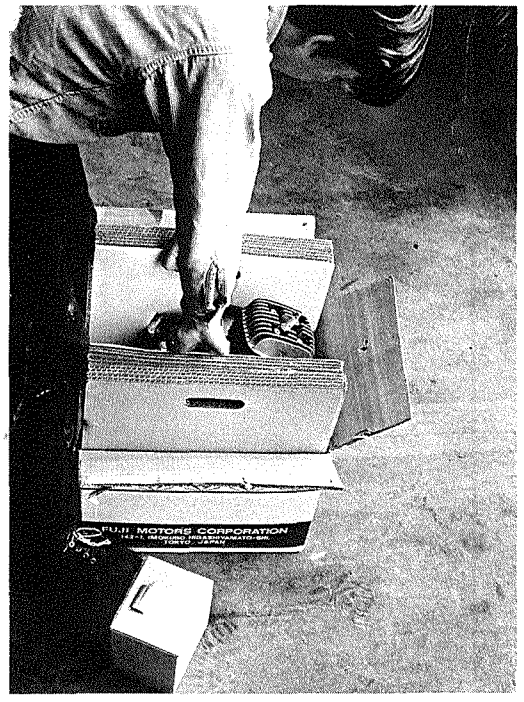
Most of these old minibikes have perfectly usable chassis, and would require only new engines with motorcycle-type transmissions to turn them into exciting "new" machines. The problem with doing this has been in the mounting: Motorcycle engines are specifically designed to be installed in a given chassis, and putting one in a different frame can be well-nigh impossible. However, Pacific Basin Trading Co. (the Hodaka people) produces the Fuji "Phoenix," an engine designed with a universal-mounting system.

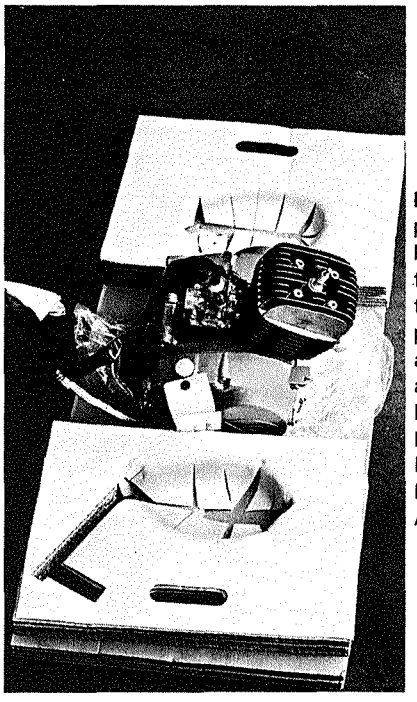
I bought a Phoenix F480, an 80-cc engine with a four-speed transmission, added a Taylor Products Model 800 muffler and installed them in a Bonanza chassis. Total installation time was about eight man-and-boy hours. Although there is an almost infinite variety of minibike designs, this chassis is pretty much typical of the platform-frame bikes.

With two-cycle engines such as the Phoenix, maximum power is obtained by means of an expansion chamber—one of the finest noise generators devised by the mind of man! In this installation we were primarily interested in a tractable, *quiet* machine, rather than having a super-fast, noisy one.

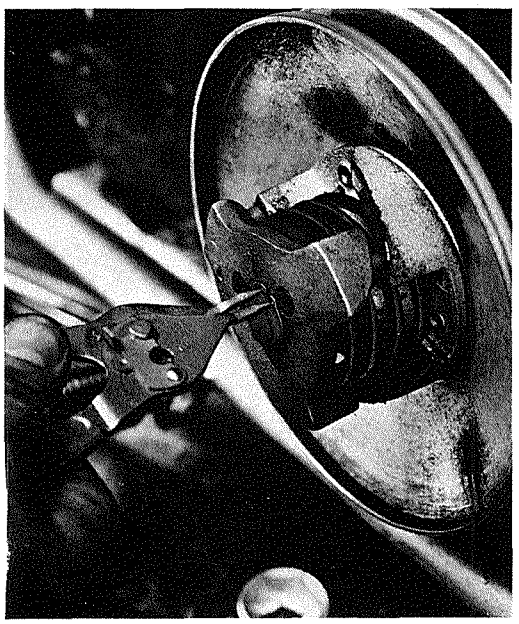
SEE ALSO

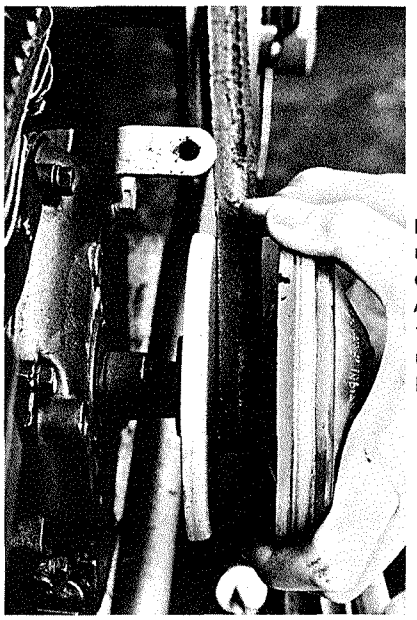
Bicycles . . . Engines, small . . . Fire engines . . . Motorcycles



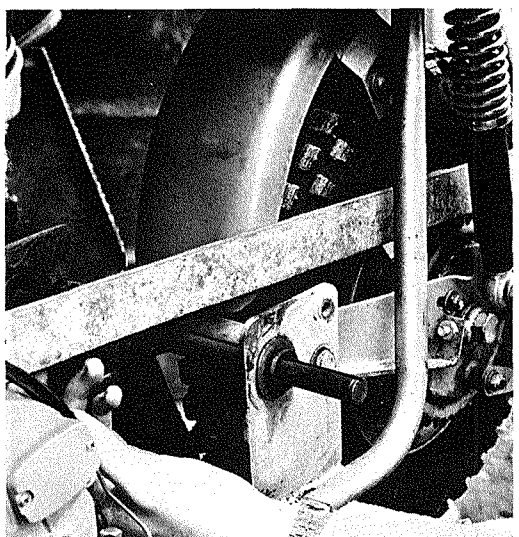


ENGINE THAT ADAPTS easily to platform-frame minibikes is the Phoenix F480 from Hodaka. The 80-cc two-stroke is complete with four-speed transmission and is compactly packaged. All you do is add a muffler and exhaust system and route it appropriately for your machine. The F480 engine can be obtained from your local Hodaka dealer or distributor. For the one nearest you, write to Hodaka Motorcycles, Box PM-327, Athena, Ore. 97813.





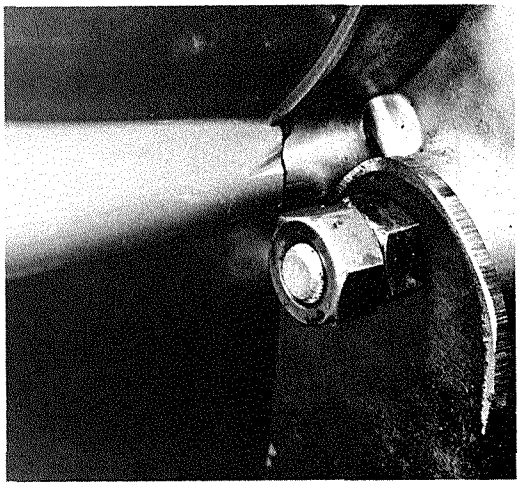
REMOVE OLD ENGINE from the minibike frame. At far left, the torque converter is being readied for removal. After all hardware is loosened and taken off, pull the unit off (left). Clean up the frame and possibly paint it before mounting the new engine.

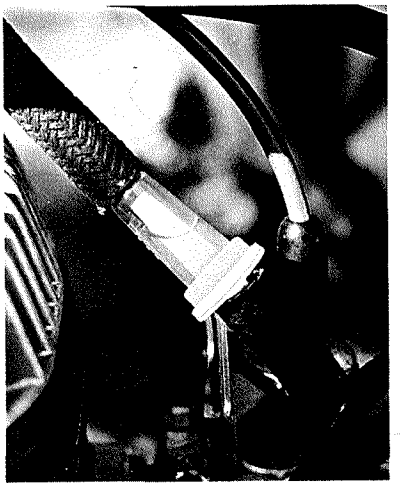


ENGINE MOUNTS are shaped on a grinder (left) as necessary before you install the new engine. Align the new mill before tightening it in place: With rear wheel centered in the frame, align the sprockets. Check chain clearance with a straightedge or yardstick as shown at far left. Allow at least ¾-inch clearance between the drive chain and swing-arm cross member.

ENGINE MOUNTS (shown at right) should have all edges rounded. Note double-nutted mounting bolt. Engine mounting bolts should be double-nutted or secured with Loc-tite.

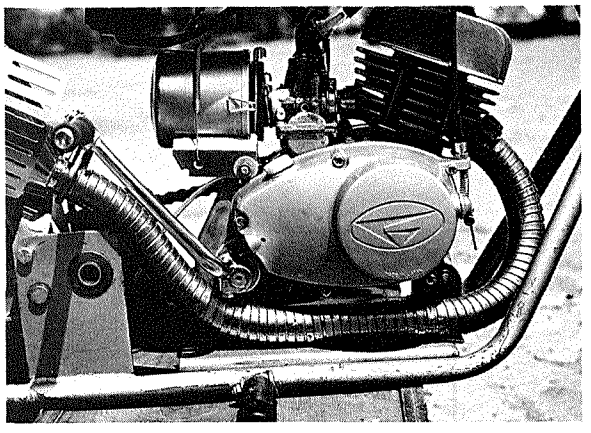
IN-LINE FUEL FILTER (far right) should be used with all mini-bikes since bikes are usually refueled from cans, often under undesirable conditions.





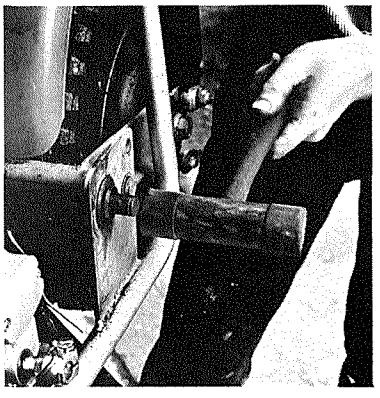
EXHAUST PIPE was fashioned from flexible steel tubing (right). Always run the exhaust tubing along the top of the frame, never underneath it where it would be damaged easily.

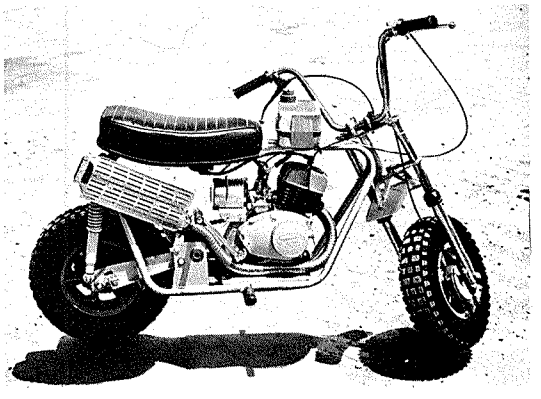
REPAIR LINKS often fail because they're installed dry. At far right, master link is lubricated with a Teflon-moly compound before the chain is installed.



OLD JACKSHAFT can be left on the minibike, but if there's a possibility it may be used again, knock it out with a soft hammer, as shown at right.

CONVERSION COMPLETE, minibike is ready to ride. Note that the 0.4-gallon fuel tank is secured to the frame with silver duct tape, a practice common in motorcycle racing.





If you do the job, the toughest part will be with the exhaust pipe. The average automotive muffler shop is unable to cope with the 1¼-inch inside diameter pipe. We solved that by using flexible-steel exhaust tubing, obtainable at industrial-equipment outlets and better auto parts houses. Its only disadvantage is that it is not oil-tight and rather messy, although it seals itself fairly well after use.

Most minibikes had jackshafts in a crossover configuration, that is, power input on one side—usually the left—and output to the rear sprocket was on the other. When installing a Phoenix, every effort should be made to eliminate the jackshaft as a power-waster and maintenance headache. Usually the rear wheel can be turned around and the sprocket installed on the left side.

You can put the brake mechanism on the left, or just eliminate the rear brake. I prefer the latter and accomplish rear-wheel braking by downshifting the engine.

Sticky problem

I want to cover the tops of a chest of drawers and a small table with plastic laminate. Can I do this with contact cement? What's the procedure in preparing the surfaces? Can I cut the laminate with a handsaw? If not, how?—C.U., N.Y.

Yes, contact cement can save you time and clamps. It sticks—but you must work quickly. The surfaces of the table and chest tops should be sanded smooth without any bumps or dents. If edges of the tops are molded you'll have to make sure the laminate is cut to exact size—you can't easily work down an overhang with a file or rasp after the material is in place. Usually it's best to make cardboard patterns of the tops, then take these to your dealer and have him cut the laminate to the patterns. The cutting charge will be nominal and it will save you a lot of time.

Coat the bottom face of the laminate and the tops with the cement, following the application instructions on the container. Let coatings set until very tacky.

Now comes the tricky part: Hold the laminate with both hands and position one edge flush with the edge of the table top. Make sure this edge is correctly positioned, then press the edge into contact with the table and gradually lower the laminate sheet, pressing outward from the center. Once the laminate is in full contact, smooth it quickly in two directions from the center. Remember, you cannot shift the material once it is in contact. If edges of the tops are square, apply strips of matching laminate to these first, smoothing top edges flush with a rasp.

Leaky leaded glass

I have a small, leaded-glass window with several panes built into my front door. When there's a driving rain, water leaks through. I'm told that epoxy will stop the leaks. Right?—P.R., Vt.

Possibly. But to me the real problem is to locate the exact points of leakage. Water might be driven into the joint between lead and glass, travel along the joint and then spill inside some distance away. I once solved this problem by "re-running" the leaded joints at several points with a small electric soldering iron, using a damp cloth as a heat sink. Of course, you must be certain of the exact location of the leak beforehand and extreme care must be used to heat the lead just to the melting point, no more. I spent some time cleaning the joints involved to make sure that all dust and any other debris had been removed. The procedure did stop the leaks. True, there is risk of cracking the glass but if you use extreme care, this hazard can be reduced to the minimum.

Water marks on doors

My basement flooded to a depth of 6 in. or so last fall, leaving water marks on two doors leading to an adjoining recreation room. No other damage is apparent. The doors are a laminated or hollow type and have been stained a reddish-brown color. Can I eliminate the water marks without completely refinishing the doors?—N.H., Mo.

Possibly. Get a small tube of artist's color in burnt sienna and thin a small amount of the color with turpentine to form a paste. Apply this to the marked surfaces with a soft cloth, rubbing the color off until you get a shade matching that of the unmarked areas. This light staining must be allowed to dry thoroughly and then can be coated with a semi-gloss varnish. However, if the burnt sienna color first appears too reddish, add a small amount of burnt umber to the prepared stain before application.

Closed vs. open sump

I have a minor water problem in my basement and my plumber proposes to install a closed sump; that is, a tile set on, or in, a concrete bottom. He says an open-bottom sump will cause the pump to run almost continuously. What is your opinion?—M. Wheeler, Cleveland.

Your plumber is better able to advise you than I, at such long range. He is thinking, no doubt, that the water table in your locality varies, perhaps with the seasons, but may seldom be entirely below the level of the proposed sump. If the sump has the open bottom and is on a gravel or sand stratum, your pump would tend to run more or less continuously.

I must assume, of course, that only storm water will enter the sump—that is, water seeping to subsurface levels. In the type of installation proposed, the pump would operate only when water seeping into the basement enters the sump.

In dry periods, the sump must be kept clean by occasional flushing; it should be tightly covered.

Raveling cord ends

How can I prevent the cut ends of braided and twisted cord from unraveling?—Irving Arnham, St. Louis.

Usually by dipping the cut ends in white glue or shellac. Cut the ends off square and dip them about ½ inch into the liquid; then wipe off the excess and let the ends harden before using the cord.

by W. Clyde Lammey

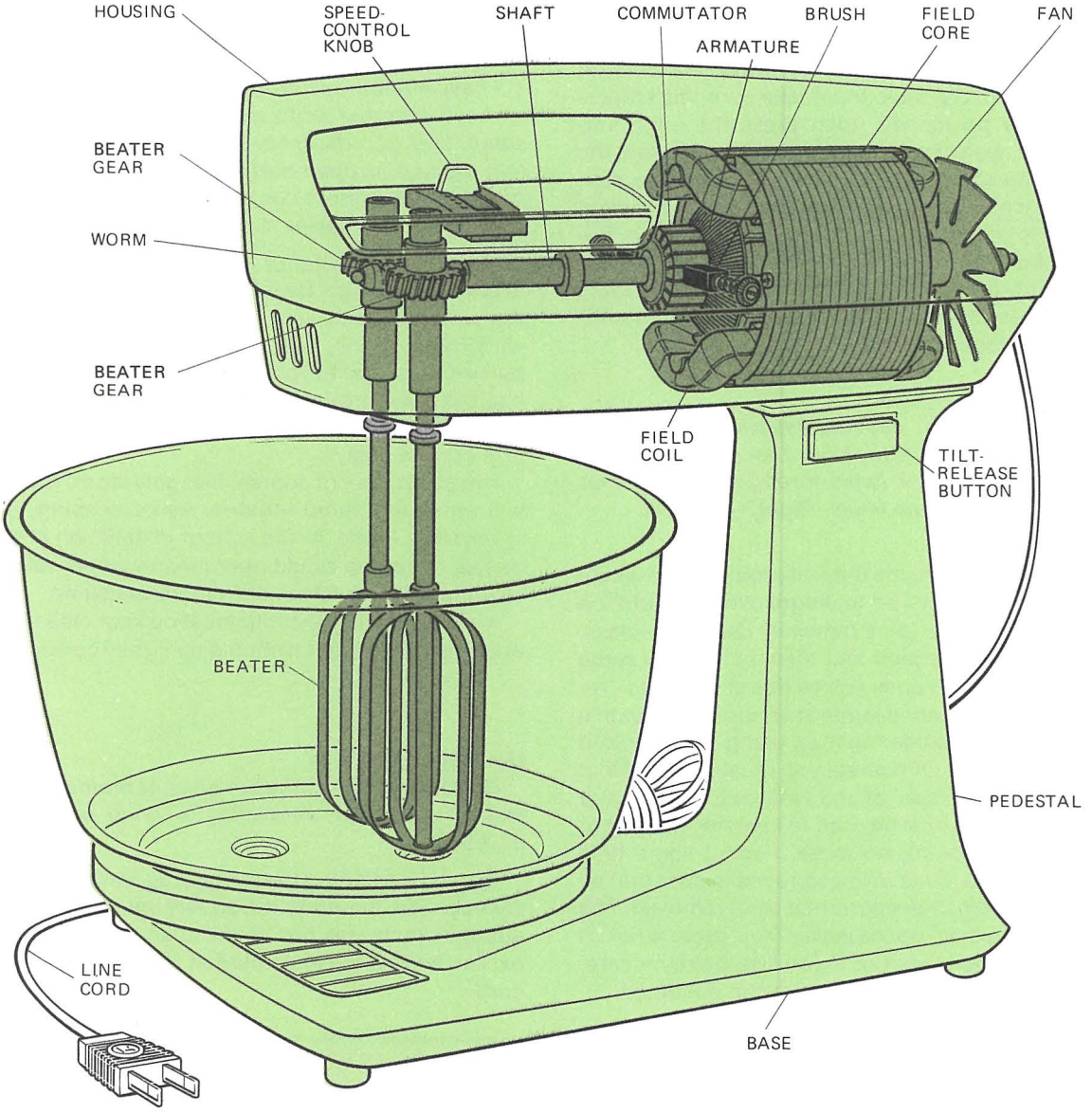
■ MOST electric food mixers are powered by motors of the universal type with carbon brushes. This type of motor develops high torque and speed, but is noisy and, because the brushes tend to spark, requires capacitors to prevent radio and TV interference. To deal with foods of different consistencies, the motor must turn at different speeds. The three common methods of speed control are a centrifugal switch, tapped field and adjustable brushes.

The centrifugal switch is a governor that keeps the motor at the desired speed by shutting off and restoring current. When the motor is off, its contacts touch (see page 2019). The contacts stay together until the motor reaches a speed at which centrifugal force overcomes spring tension and the contacts separate, breaking the circuit. The motor then slows until the spring can bring the

How to troubleshoot a food mixer

Many of the troubles of the electric mixer can be solved without even taking the unit apart. Whatever the difficulty, the comprehensive charts on these pages may help you diagnose and then solve the problem

TYPICAL MIXER COMPONENTS



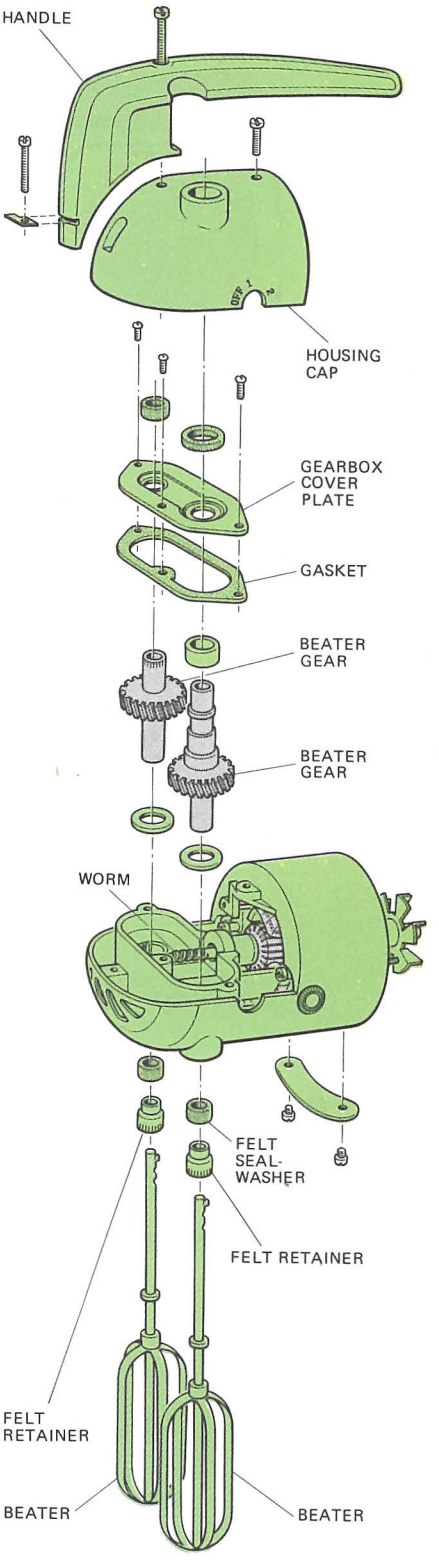
contacts together again. The cycle is short enough that the motor runs smoothly. Speeds are varied by moving the adjustable contact.

With tapped-field control, parts of the field coil are cut out of the motor circuit, giving it lower resistance and producing higher speed. At low speed, the entire coil is used. A medium setting, using part of the tapped coil, provides moderate speed.

PEDESTAL MIXER: GEARBOX

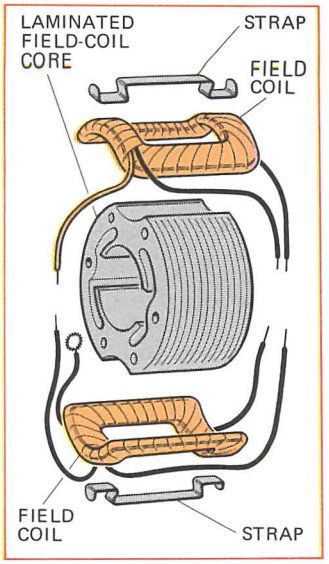
Motor does not run

POSSIBLE CAUSES	WHAT TO TRY
1. No power.	Check for power at wall outlet with 115-v. test lamp. If there is no reading, replace line fuse or reset circuit breaker.
2. Defective cord.	Disconnect cord from outlet and then from motor casing. Test wires in cord for continuity. If either gives no reading, replace cord.
3. Worn brushes.	Remove brush caps from mixer housing. Pull out carbon brushes. If they have worn down to ¼ in. or less, replace them.
4. Defective on-off switch.	Remove switch and inspect contacts for pits or burned spots. Clean contacts with a fine file or sandpaper (do not use emery cloth). Test for continuity across terminals. If there is no reading with switch on, replace it.
5. Open field coil.	Test coil for continuity with one probe at wire junction of the cord, capacitor and field lead, other at lead from coil. There should be a reading. Also test between other coil lead and lead to brushes. There should be a reading. If there are no readings, replace field coil or check price of a new mixer.
6. Open armature winding.	Test for continuity across each segment of the commutator. Replace armature if any segment gives no reading. Test for armature short by placing one probe on commutator segment and the other on armature body. Replace armature if there is a reading.
7. Centrifugal switch stuck open.	Press switch closed. Clean all moving parts of the switch and put a drop of oil on the pivot point—do not over-oil.



SEE ALSO
Appliance centers . . . Garbage disposers . . . Kitchens . . . Ranges . . . Refrigerators . . . Toasters . . . Trash compactors

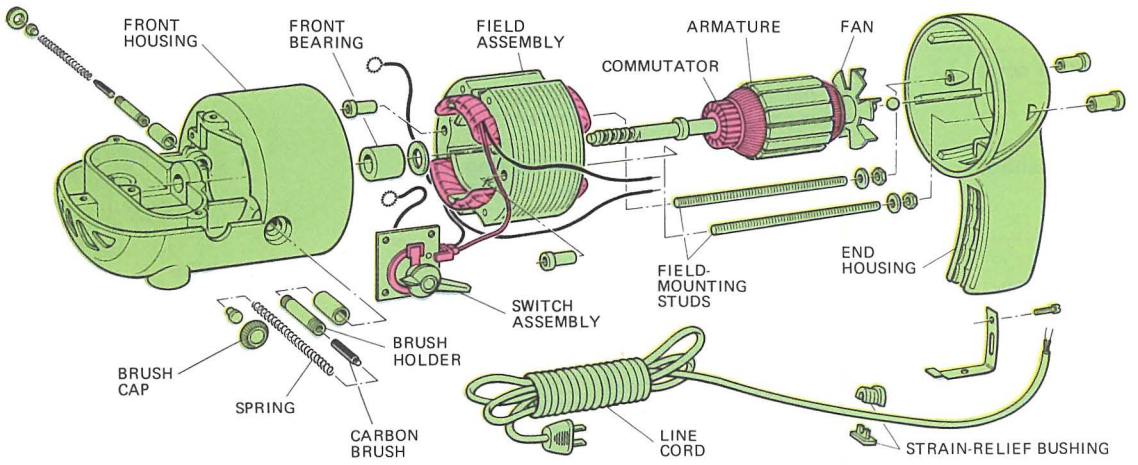
continued



FIELD ASSEMBLY

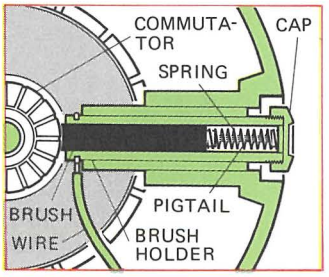
Motor does not run, blows fuses

POSSIBLE CAUSES	WHAT TO TRY
1. Jammed bearings or spindles.	Remove gear housing. Apply penetrating oil to spindles; remove them at setscrews. Clean gear case, spindle holes with trichloroethylene solvent. Replace worn, broken gears. Grease gear compartment with proper lubricant, reassemble.
2. Jammed armature.	Disassemble mixer. Straighten or replace armature shaft. Spin armature by hand to check for clearance. Reassemble mixer.
3. Shorted line capacitor.	Test capacitor for continuity. There should be a reading for a split second. If no reading or if it is permanent, replace the capacitor.
4. Defective field coil or armature.	See preceding chart.
5. Shorted line cord.	Remove cord from outlet and then from motor casing. Test for continuity across plug prongs. If there is a reading, replace the cord.



MOTOR ASSEMBLY

TYPICAL BRUSH ASSEMBLY



Motor overheats

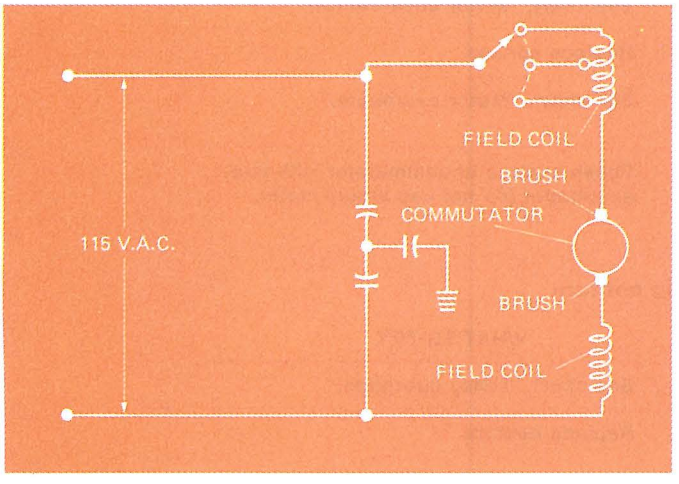
POSSIBLE CAUSES	WHAT TO TRY
1. Centrifugal switch stuck closed.	Remove switch, separate contacts by hand. Check contacts for pits or burned spots. Clean with fine file or sandpaper (*not* emery cloth). Put a drop of oil on pivot point—do not over-oil.
2. Motor dirty.	Clean motor air intake with vacuum cleaner. Remove stubborn dirt with small toothbrush. Do not use solvents on internal motor parts.
3. Field coil or armature shorted or grounded.	Look for burn marks near edges of commutator segments, indicating a shorted or grounded winding. Test for continuity between commutator segment and shaft; a reading indicates a short or ground. Test field coil with one probe on coil lead, other on mixer housing. Replace any parts that produce readings.

Motor speed erratic

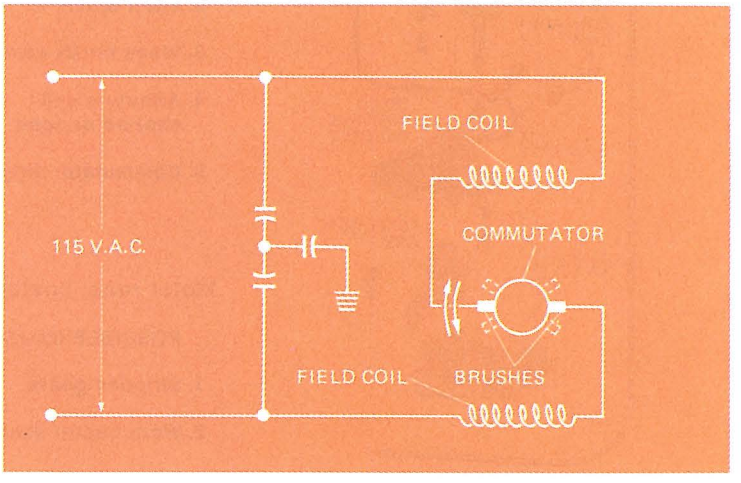
POSSIBLE CAUSES	WHAT TO TRY
1. Defective cord.	Test each side of cord for continuity while wiggling cord. Any variation in reading indicates a break. Replace cord.
2. Worn brushes.	See chart, "Motor does not run."
3. Loose connections.	Check all solder joints and wiring insulation. Correct any defects found.
4. Defective motor speed control.	See chart, "Motor overheats." Check tapped field by testing for continuity across resistor. Replace resistor if there is no reading. Test motor capacitor; see chart, "Motor does not run, blows fuses." Check adjustable-brush control by examining brushes; see chart, "Motor does not run."

continued

TAPPED—FIELD SPEED CONTROL



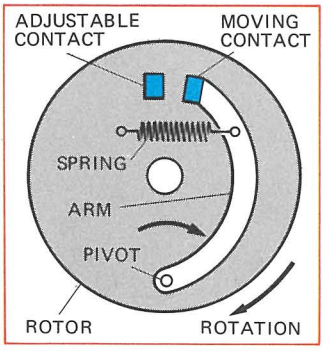
ADJUSTABLE—BRUSH SPEED CONTROL

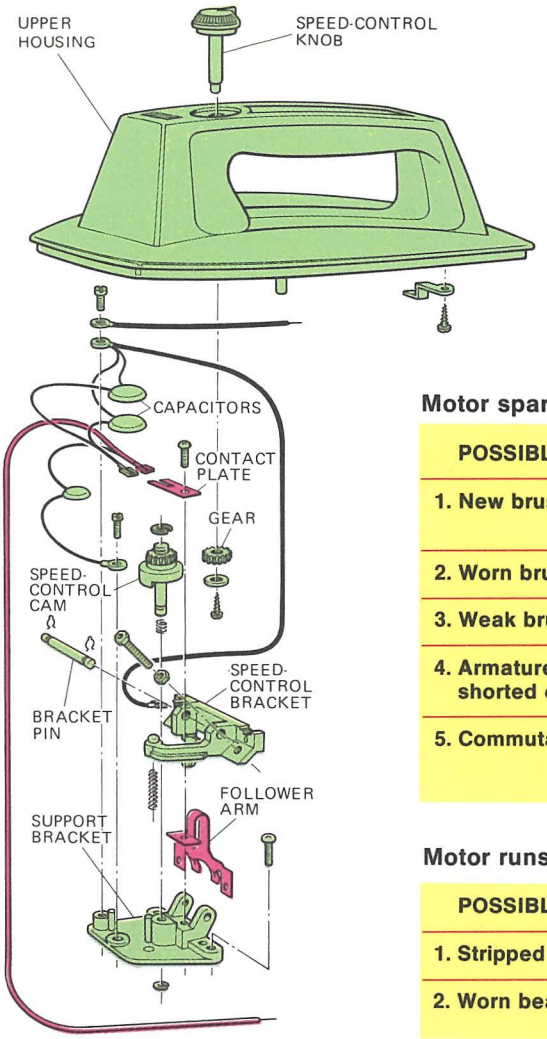


Noisy operation

POSSIBLE CAUSES	WHAT TO TRY
1. Worn bearings.	Tighten or replace bearings.
2. Play at end of rotor.	Shim rotor end with small thrust washers, .005 to .025 in. thick.
3. Motor dirty.	See chart, "Motor overheats."
4. Gears broken or dry.	Remove gear housing, check for chipped or broken gear teeth or lack of lubricant. Replace all worn or broken gears and grease with the recommended lubricant.
5. Bent beaters.	Straighten beaters so they clear each other.
6. Bent fan blades.	Straighten fan blades to clear housing.

CENTRIFUGAL—SWITCH CONTROL





CAUTION: Be sure power is turned *off* before you handle components. Make all continuity tests with power *off.* When using a test lamp, keep power *off* while connecting and disconnecting the lamp. Use your manufacturer's manual to locate components, and use only replacement parts that meet his specifications.

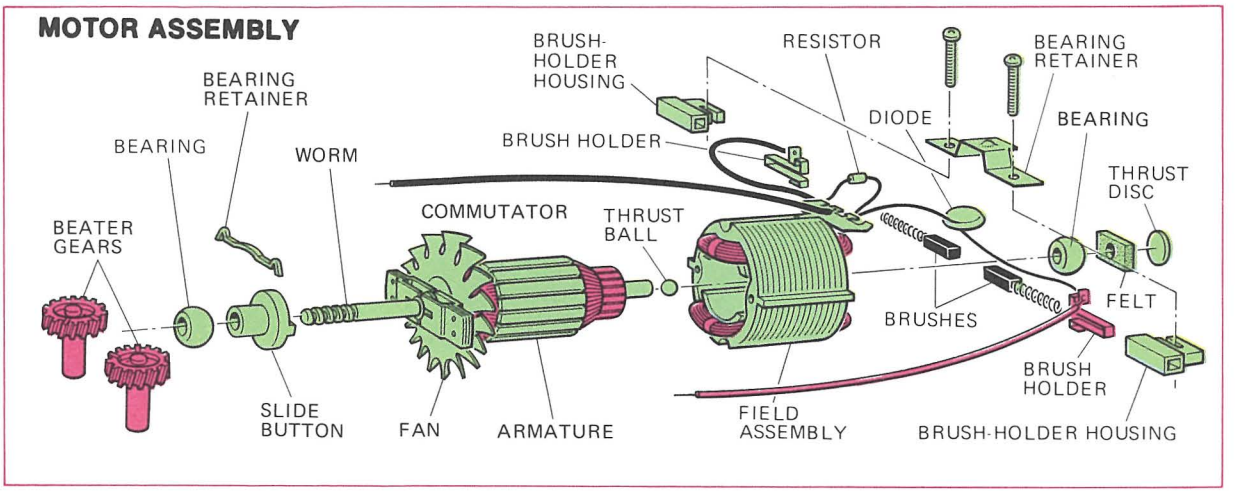
Motor sparks at brushes

POSSIBLE CAUSES	WHAT TO TRY
1. New brushes.	Normal condition until new brushes wear to fit contour of commutator.
2. Worn brushes.	See chart, "Motor does not run."
3. Weak brush springs.	Replace springs.
4. Armature coil shorted or open.	See chart, "Motor overheats."
5. Commutator dirty.	Polish surface of commutator with fine sandpaper (do not use emery cloth).

Motor runs; beaters do not turn

POSSIBLE CAUSES	WHAT TO TRY
1. Stripped gears.	See chart, "Noisy operation."
2. Worn beater shafts.	Replace beaters.

HAND-MIXER: UPPER SECTION AND CONTROLS



Motor runs slowly or lacks torque

POSSIBLE CAUSES	WHAT TO TRY
1. Wrong speed for load.	Change speed.
2. Load too heavy.	Not mixer's fault; don't use on unusually stiff mixtures.
3. Worn brushes.	See chart, "Motor does not run."
4. Rotor binding.	Check for proper end-play clearance—this clearance should be .005 in.
5. Centrifugal switch stuck closed.	See chart, "Motor overheats."
6. Field coil grounded to mixer housing.	Place one probe of 115-v. test lamp on mixer housing, other probe on known ground. If there is a reading, replace field coil or check price of a new mixer.

Motor runs continuously

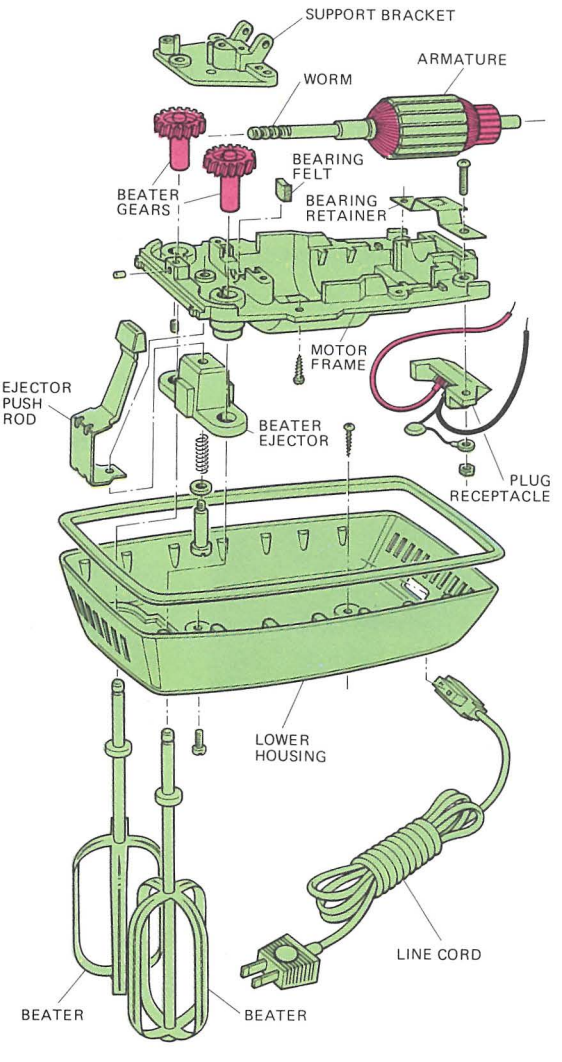
POSSIBLE CAUSES	WHAT TO TRY
1. Switch dial broken.	Cam pin broken or worked loose. Replace.
2. On-off switch shorted.	Test for continuity across switch terminals with switch off. Replace switch if there is a reading.

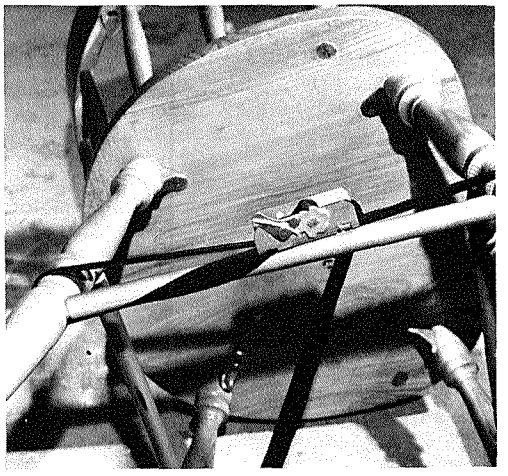
Adjustable-brush control provides lower motor speeds by moving the brushes away from their position of maximum efficiency with respect to the commutator. This type of control reduces torque as it reduces speed, and for this reason is not commonly found on new machines.

At one time or another, a food mixer will require lubrication for proper performance. Some mixers have accessible oil holes or grease cups that permit lubrication without disassembly. If water or another liquid has found its way into the gearbox, all of the old grease should be removed and the compartment repacked with grease of a weight recommended by the manufacturer of the mixer.

Many mixer problems can be solved without taking the appliance apart. Stuck beaters can be loosened by squirting penetrating oil into their sleeves. Bent beater blades can be straightened, although a bent beater shaft usually requires replacement. If beaters slip in their spindles, the trouble is usually a worn shaft that should be replaced. Brushes are accessible through caps on the mixer housing. When you must take a mixer apart, keep careful track of the sequence of disassembly so that you can reverse the process with a minimum of difficulty.

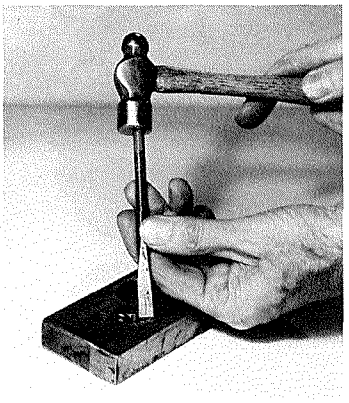
LOWER SECTION AND GEARBOX

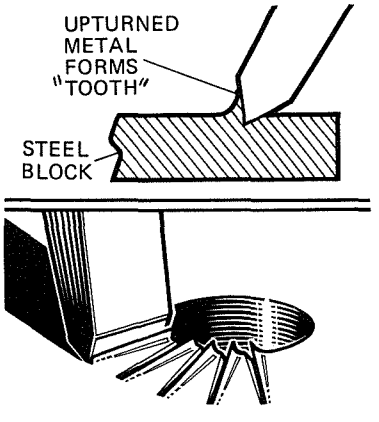




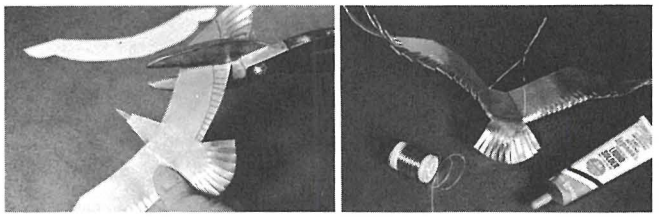
BELT-CLAMP SLIPPAGE after you have all parts glued and aligned can be pretty frustrating. Though this clamp is ideal for such repair jobs as wobbly legs on a chair, it does tend to slip due to leg taper. You can stop this from happening by looping one end of the clamp around a chair rung as shown. The stunt works for me every time I use it.—*Robert Brightman, Great Neck, NY.*

A TOTABLE ANCHOR is a necessity when we want to fish a particularly good spot in our rubber boat, because the slightest current or breeze will cause our boat to drift. Shown at the left is a simple anchor that we use. It consists of an old fishing bag filled with rocks found at the fishing site and a length of sturdy rope. When you're through for the day, simply dump out the rocks and store the fishing bag for your next outing. To make certain that it's always at hand, keep the fishbag inside of the deflated and folded boat.—*John Krill, North Lima, OH.*



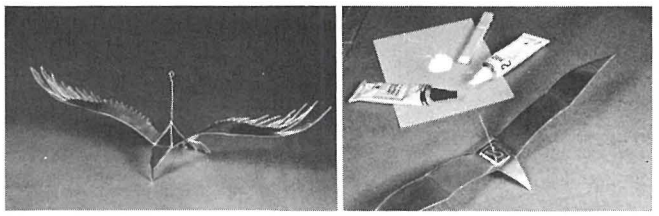


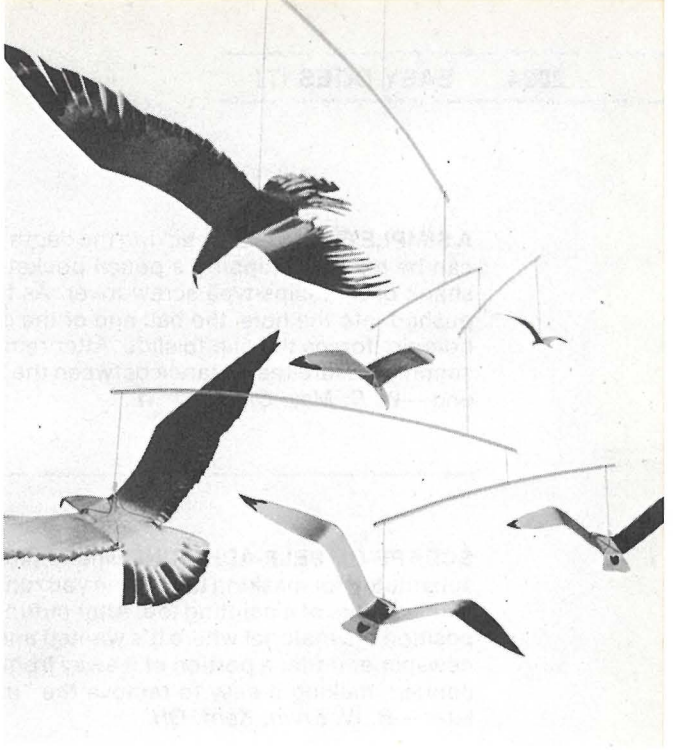
A SCRAP STEEL BLOCK can be converted in minutes into a "tool" for forming tenons on the ends of wood dowels and rungs. A hole with the diameter of the desired tenon is drilled through the block. Then, a sharp cold chisel is used to form a series of cutting edges around the hole on the block surface. The resulting teeth resemble those on a rasp and are positioned so they cut when the dowel is rotated clockwise against them. After tapering the tip of the dowel, you can chuck it in a drill press or hand brace-and-bit to do the cutting. When the teeth wear out, simply flop the block and use the other side.—*Walter E. Burton, Akron, OH.*



Snips (left) cut feathers in wings, tails of larger birds. Fasten thin wire hangers (right) with "liquid solder"

Two wires twisted together (below left) make the hanger. Simpler hanger can be epoxied onto smaller gulls (right)





Flying seagulls!

By RAY GILL

Here's a project that is as fun to make as it is to watch spinning in the breeze. The birds are made of sheet aluminum

■ THIS DELIGHTFUL, breeze-sensitive mobile is easy and inexpensive to make. Large and small seagulls are cut from stiff 3x3-ft. aluminum sheets sold in hardware stores. One will cost about $5, surely not over $10.

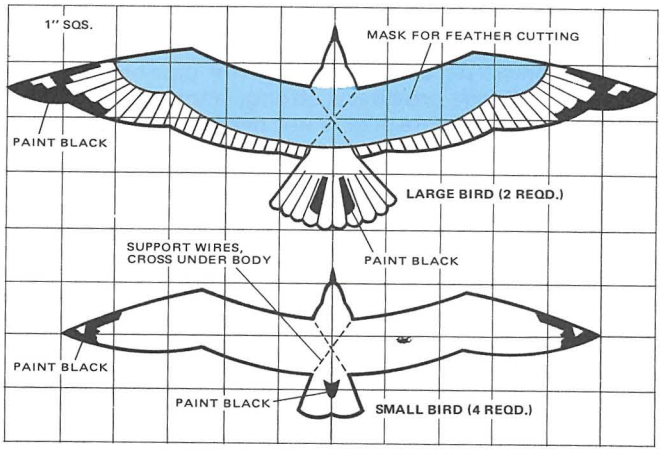
Metal snips or household shears will cut the sheet, but a hobby jigsaw works best. Tape the metal to scrap wood to prevent its rattling. Cut the pattern (below right) from paper or cardboard and mark the feather-cutting line with a felt-tip pen or grease pencil. Cutting feathers will produce a natural curl. Make 'em match.

For stability, each gull has a stiff wire hanger twisted around the body and secured with metallic glue. The upright part of the hanger should be longer when wings are bent upward, as in the third photo opposite. The end loop of each hanger should be about ¼ in. higher than the highest parts of the wings. For the smaller birds, hanger wires can be attached to plywood rectangles which are then fastened to gulls' bodies with epoxy.

Stiff, $^1/_{16}$-in.-dia. steel rods are the right size for the mobile in the 36-in. lengths in which hardware stores sell them; no cutting is necessary. Birds are suspended from them with colorless nylon thread, and knots are fixed to the rods with quick-drying glue (make sure that all oil is removed from the rods so that the glue will hold).

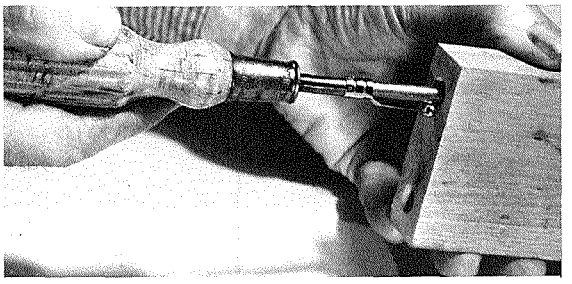
Assemble the mobile like this: Start at the bottom and attach both larger birds to the ends of the first rod with short lengths of thread. Find this rod's balance point and fasten thread to it.

Fasten the other end of the thread to one end of a second rod. Attach a small bird to the other end of this rod, find the balance point, and proceed on up. Tie the top thread to a small metal ring so the mobile can be suspended easily.



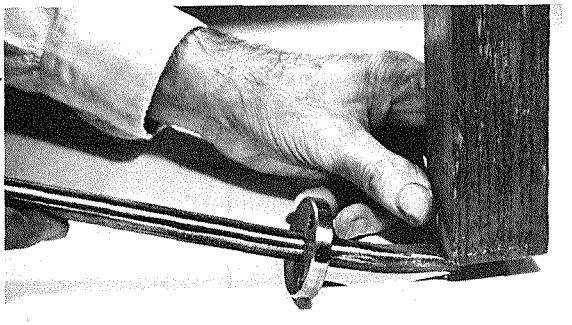
SEE ALSO

Art glass . . . Bottle craft . . . Christmas decorations . . . Internal carving . . . Jewelry . . . Lapidary . . . Marquetry . . . Metal casting . . . Plaster casting . . . Potter's wheels . . . Rug hooks . . . Velvetizing

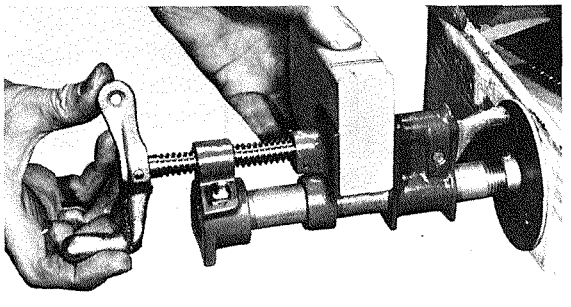


A SIMPLE GAUGE for checking the depth of a bored hole can be made by slipping a pencil pocket-clip over the shank of a Phillips-type screwdriver. As the driver is pushed into the hole, the ball end of the clip against the hole rim forces the clip to slide. After removing the tool, simply measure the distance between the tip and the ball end.—*W. B. May, Oak Park, IL.*

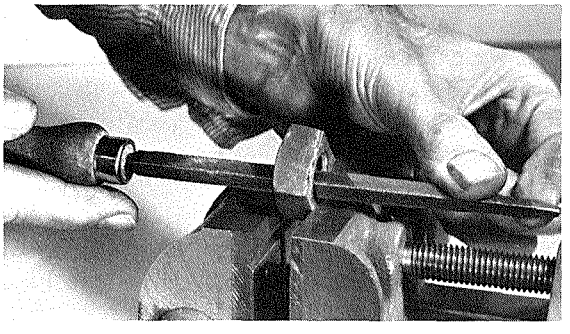
SCRAPS OF SELF-ADHERING shelf-lining can be substituted for masking tape when you run out of the tape in the middle of a painting job. After cutting it into strips, position the material where it's wanted and use a sheet of newspaper under a portion of it away from the edge to be painted, making it easy to remove the "masking tape" later.—*B. W. Ervin, Kent, OH.*



YOUR PRY-BAR can operate effectively within a greater range if it is equipped with an adjustable, sliding collar. The bar shown is of ½-in.-steel rod and the ⅜ by 1¾-in. collar was salvaged from my scrap box. The collar was drilled and fitted with two ½-in. setscrews to lock it in place.—*Walter E. Burton, Akron, OH.*



A PORTABLE VISE can be made by attaching several ¾-in. pipe flanges of varying length to a workbench. This makes it possible to use any ¾-in. pipe bar clamp as a vise. The flange provides a strong, stable base for the clamp; when the extra vise is not needed, I simply unscrew the clamp and hang it on the wall.—*Paul R. Roman, Maple Heights, OH.*



CLOGGED THREADS on a bolt may be cleaned by screwing a nut, which has about a half-dozen notches spaced at intervals across its threads, onto the bolt. The notched nut removes rust and dirt by a scraping action (much like a die chip trap), and once the bolt threads are clean, the nut can be replaced by an unmodified nut.—*Walter E. Burton, Akron, OH.*

Mobile entertaining, indoors and out

■ ROLL THESE THREE mobile carts out on a deck or patio and you have, in effect, an "instant" outdoor playroom all set up and ready to go for family fun and party entertaining. A brand-new concept in flexible, go-anywhere furniture developed by our editors, the carts include a complete cooking unit with electric barbecue and built-in refrigerator (see below), a wet bar with sink and running water, and a self-contained stereo music center on wheels.

MOBILE COOKING CENTER is designed for use with electric barbecue from Char-B-Que and a Sears mini refrigerator. The compartment on the right side is for the storage of supplies.

SEE ALSO

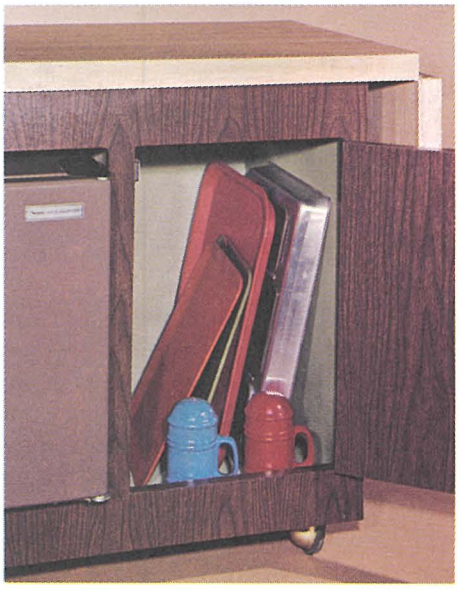
Appliance centers . . . Barbecues . . . Bars . . . Cookout bars . . . Grill houses . . . Grills . . . Hi-fi centers . . . Modular furniture . . . Patios . . . Serving carts . . . Speakers . . . Stereo

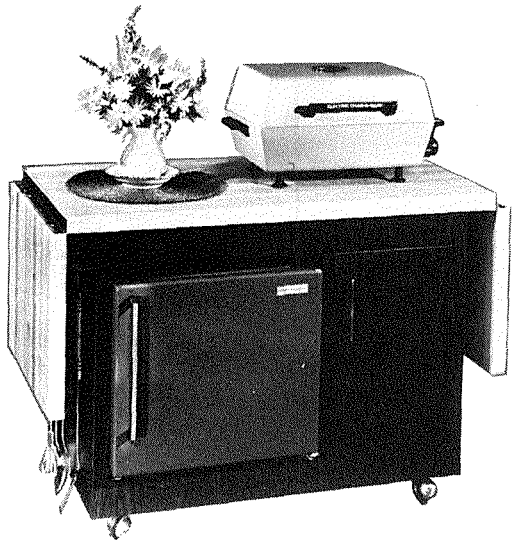
What's best about these versatile roll-abouts is that they're not limited just to outdoor use, either. There's no need to store them away between seasons while waiting for another summer to come around. Companion-styled with the smart good looks of fine furniture, they're as handsome and functional indoors as out. The cooking center, in addition to its barbecue and mini fridge, features swing-up extension wings

that make it ideal for doubling as a buffet server inside. The rolling wet bar and music center shown on these pages are match mates with hinged tops that swing down to conceal their contents when not in use. Closed, they look like sleek, modern credenzas ready for service in a living or dining area. On the next 13 pages, you will learn how to build these unusual pieces you can't buy anywhere.

1. Mobile cook-center

AT INDOOR BUFFET (above) cart becomes the center of attraction. For buffet use, a three-well food warmer replaces the barbecue setup shown on page 2025. Compact refrigerator from Sears (below) holds food and drink for typical get-together. Storage area holds cooking and serving equipment.





■ THIS COOK-CENTER has a lot going for it if you enjoy year-round entertaining. During the warm months it's sure to draw raves from your neighbors when they spot it on your patio. At season's end, you simply roll it indoors for use in the family room. And, when not in service it's a handsome piece of furniture that will suit any room decor.

The concept started with the electric barbecue cooker manufactured by the Char-B-Que Co., New Shrewsbury, NJ. The cooker can be used outside (indoors in a fireplace) for barbecues and, with its lid closed, for delicate, Chinese smoke cooking. Of die-cast aluminum, the Char-B-Que is offered in four colors—orange, yellow, avocado and black.

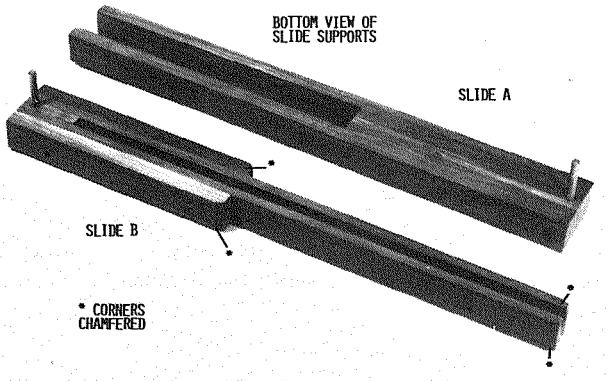
The other piece of equipment that played a major part in the cart's design is the coppertone Mini-Fridge from Sears.

The plastic-laminated countertop is an exciting product too. A handsome pattern from Formica Corp., it's called Butcherblock Maple. It looks like the real thing; in all probability, only experienced workshoppers will be able to spot the difference. The drop leaves, on which you cut and prepare vegetables, are the real thing, of course, made up of laminated strips of maple.

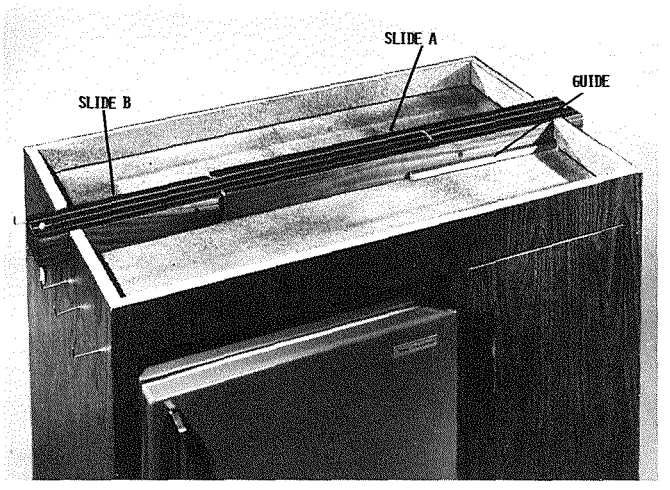
At the end of this article, you'll find a list of manufacturers of all major components used—including hardware.

To build your cart, it's a must to have your mini-refrigerator on hand. It will determine the final size of the cart (except for height). The top on the cart shown is at a comfortable, and recommended, cooking height when used with the electric barbecue. If possible, do not alter this dimension.

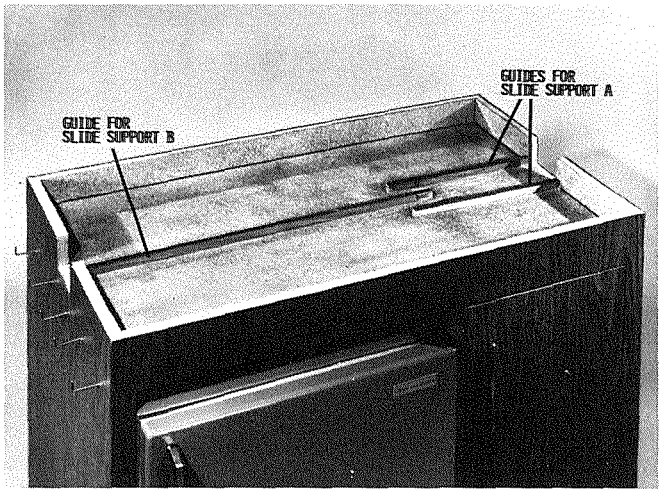
Start building by laying out the cart parts on two sheets of plywood. Before cutting, take time



DROP-LEAF SUPPORTS are of walnut; slide B inserts into slide A when slides are fully retracted.



SLIDE B TRAVELS on a single 25-in.-long guide. Slide A sandwiches between pair of 12-in. guides.



GUIDES should also be of hardwood. When satisfied with location, secure them with glue and 1-in. screws.

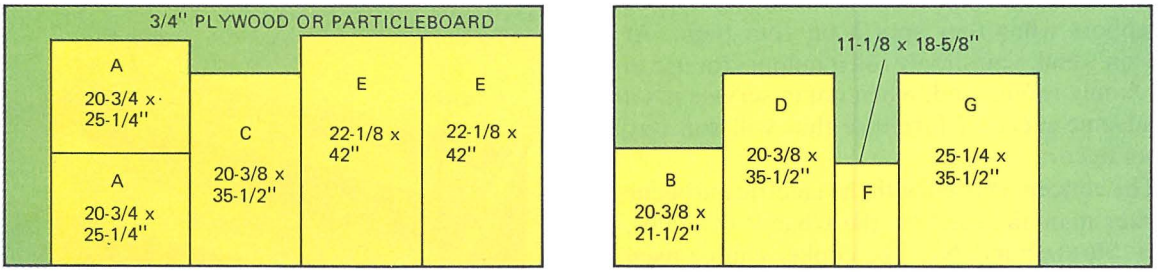
'Butcherblock' top looks like the real thing

Take time to double check measurements and proceed carefully; as a cabinet maker you must be meticulous. In this case, the reward is worth the trouble

to double check those critical dimensions concerning the refrigerator. Assemble the cabinet using waterproof glue and screws and then apply the Gunstock Walnut laminate using contact cement. You can flop the box about so you can trim laminate overhang using your router and a carbide cutter, but you will have to do some hand-filing to square the four corners in each of the two openings at front.

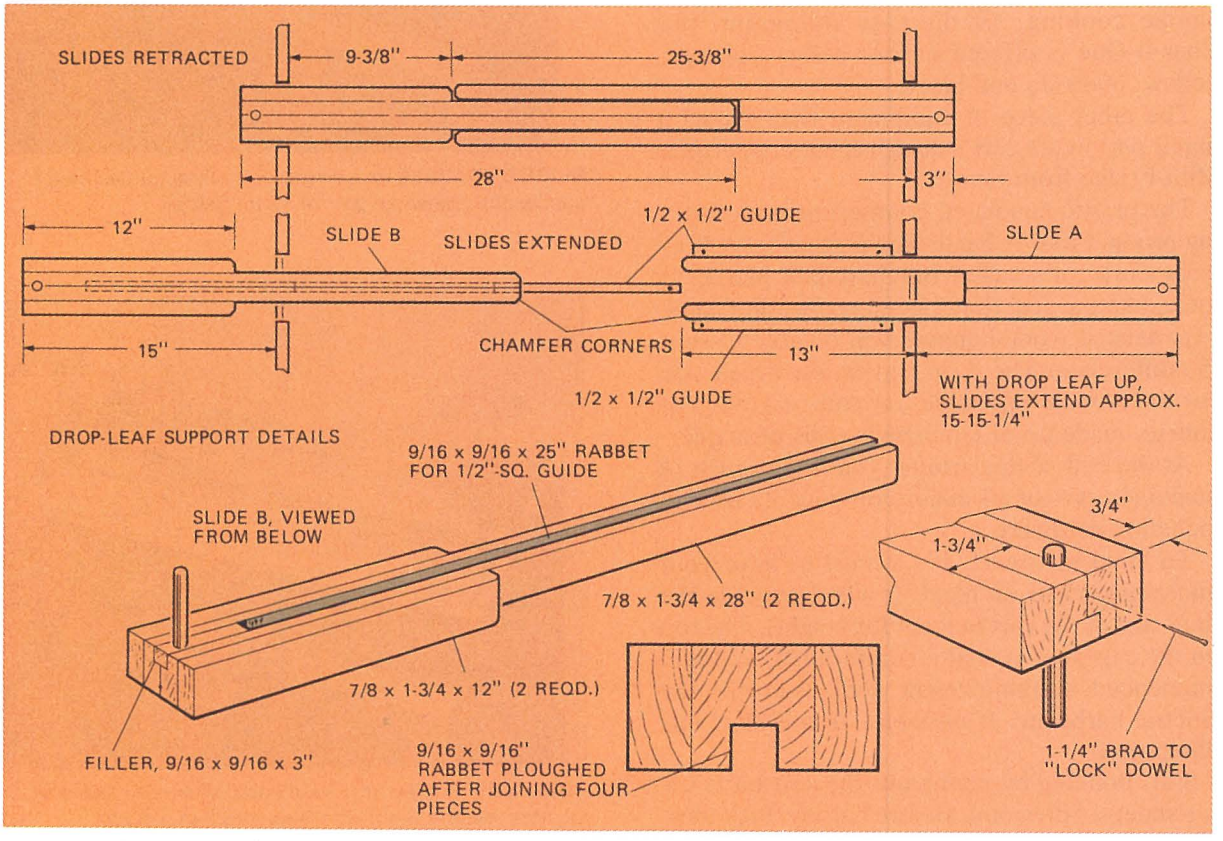
Next, make the cabinet top. After cutting the two pieces, use waterproof glue and 1¼-in. No. 8 screws to join the pieces. The top can now be

Plywood cutting schedule



PLYWOOD CUTTING SCHEDULE

How to make the slide supports



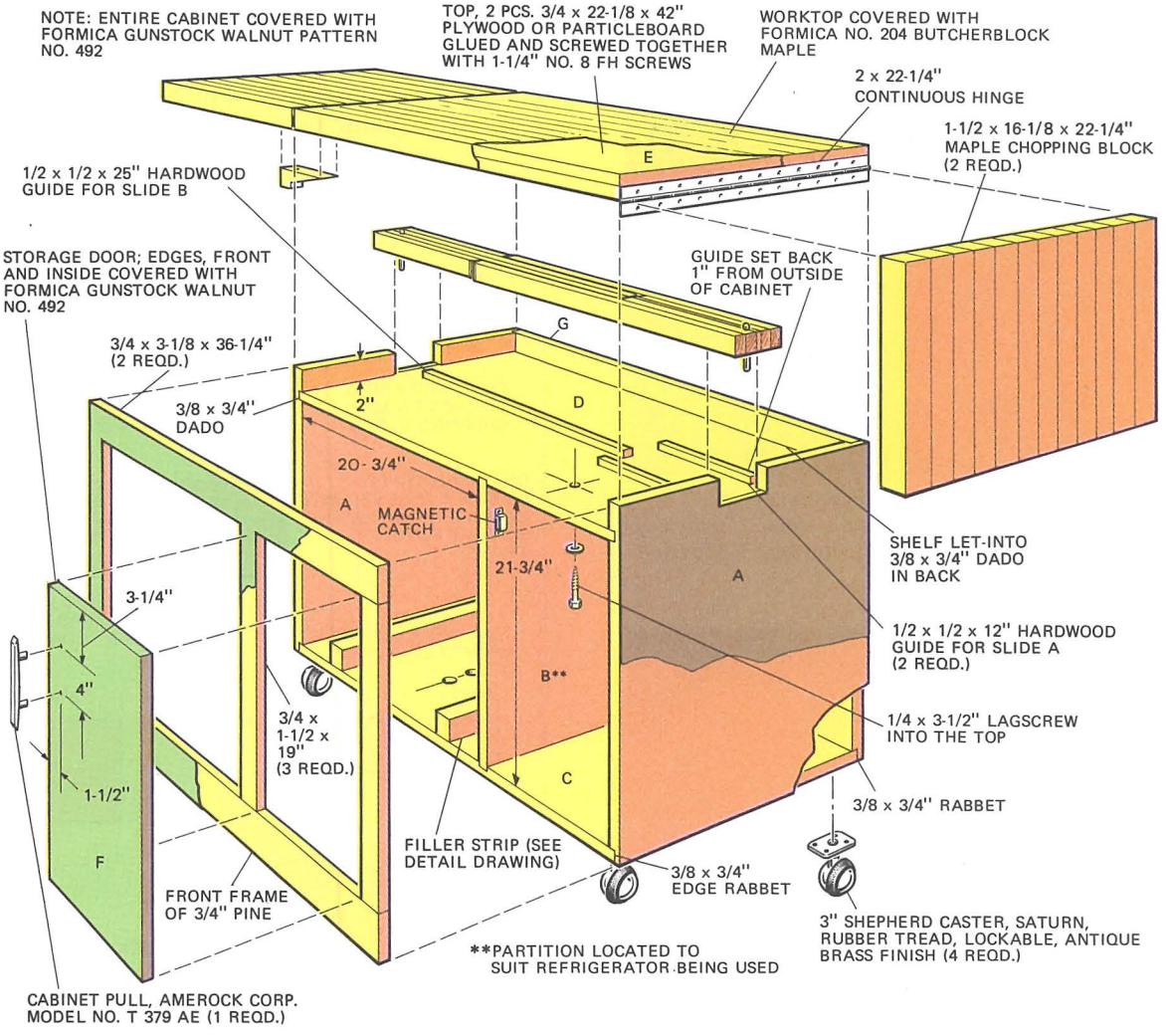
covered with plastic laminate. Do the edges first and finish by applying the top.

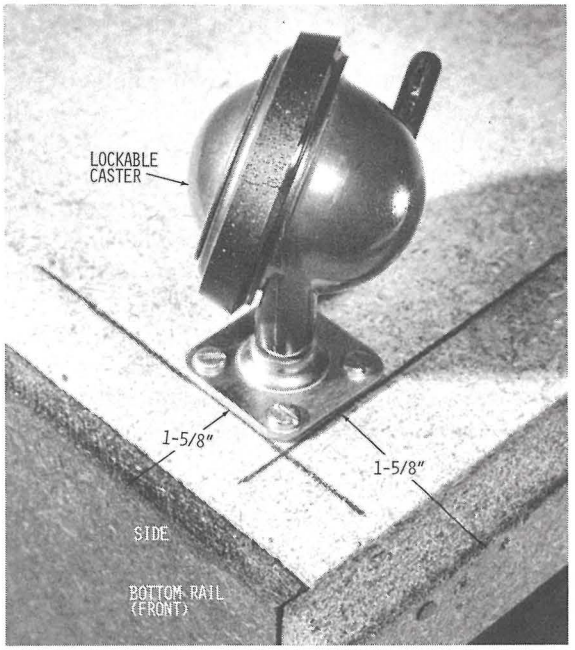
Glue-up the maple chopping blocks (or consider having this step done at your local lumberyard mill) and fasten these to the countertop using 2-in. brass-plated continuous hinge. Make absolutely certain that you drill adequate-size pilot holes in the maple chopping blocks for the hinge screws or you are almost sure to pop the heads off a number of screws.

Although the weight of the top itself holds it in place, you are well advised to anchor it using one lagscrew as shown in the drawing below. The four corner blocks prevent lateral movement of the top but at any social gathering there is a chance that a guest will lean on one of the upraised drop leaves. With the cooker going full blast, that could cause a tragedy. The single anchor, we found, absolutely prevents any chance of tilting the top.

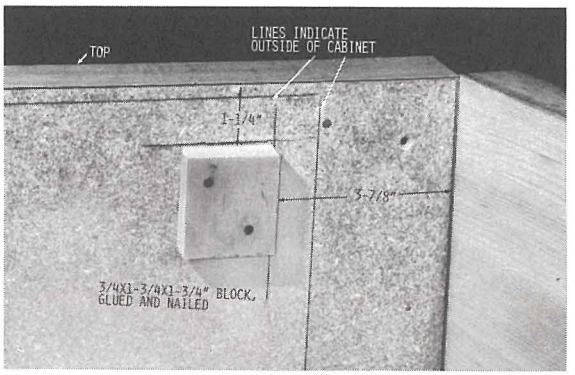
When you're satisfied with the installation, remove the lagscrew and top so that you will have less weight to handle while you work on the remaining details. For example, the cart can now

Exploded view of the mobile cook-center

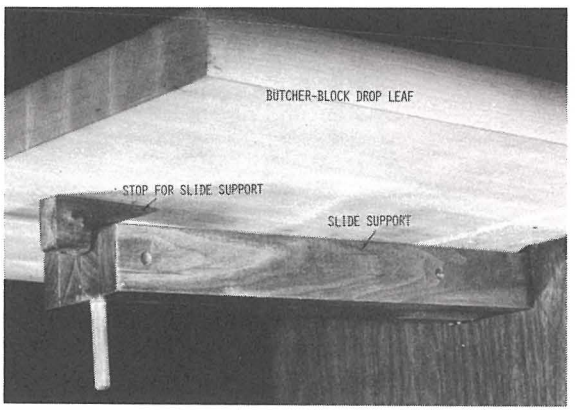

NOTE: ENTIRE CABINET COVERED WITH FORMICA GUNSTOCK WALNUT PATTERN NO. 492
TOP, 2 PCS. 3/4 x 22-1/8 x 42" PLYWOOD OR PARTICLEBOARD GLUED AND SCREWED TOGETHER WITH 1-1/4" NO. 8 FH SCREWS
WORKTOP COVERED WITH FORMICA NO. 204 BUTCHERBLOCK MAPLE
2 x 22-1/4" CONTINUOUS HINGE
1-1/2 x 16-1/8 x 22-1/4" MAPLE CHOPPING BLOCK (2 REQD.)
1/2 x 1/2 x 25" HARDWOOD GUIDE FOR SLIDE B
STORAGE DOOR; EDGES, FRONT AND INSIDE COVERED WITH FORMICA GUNSTOCK WALNUT NO. 492
GUIDE SET BACK 1" FROM OUTSIDE OF CABINET
3/4 x 3-1/8 x 36-1/4" (2 REQD.)
3/8 x 3/4" DADO
2"
20-3/4"
MAGNETIC CATCH
21-3/4"
SHELF LET-INTO 3/8 x 3/4" DADO IN BACK
1/2 x 1/2 x 12" HARDWOOD GUIDE FOR SLIDE A (2 REQD.)
3-1/4"
4"
1-1/2"
3/4 x 1-1/2 x 19" (3 REQD.)
1/4 x 3-1/2" LAGSCREW INTO THE TOP
3/8 x 3/4" RABBET
FILLER STRIP (SEE DETAIL DRAWING)
3/8 x 3/4" EDGE RABBET
FRONT FRAME OF 3/4" PINE
**PARTITION LOCATED TO SUIT REFRIGERATOR BEING USED
3" SHEPHERD CASTER, SATURN, RUBBER TREAD, LOCKABLE, ANTIQUE BRASS FINISH (4 REQD.)
CABINET PULL, AMEROCK CORP. MODEL NO. T 379 AE (1 REQD.)
A
B**
C
D
E
F
G



LOCKABLE CASTERS, by Shepherd Casters, permit cart to roll easily on patio surface. The casters used are mobility-rated at 100 lbs. each.



TO LOCATE TOP on its base, place the top on unit and measure overhang on all four sides. Then, using a pencil draw the cabinet outline on the top. Flop top and locate one block at each corner.

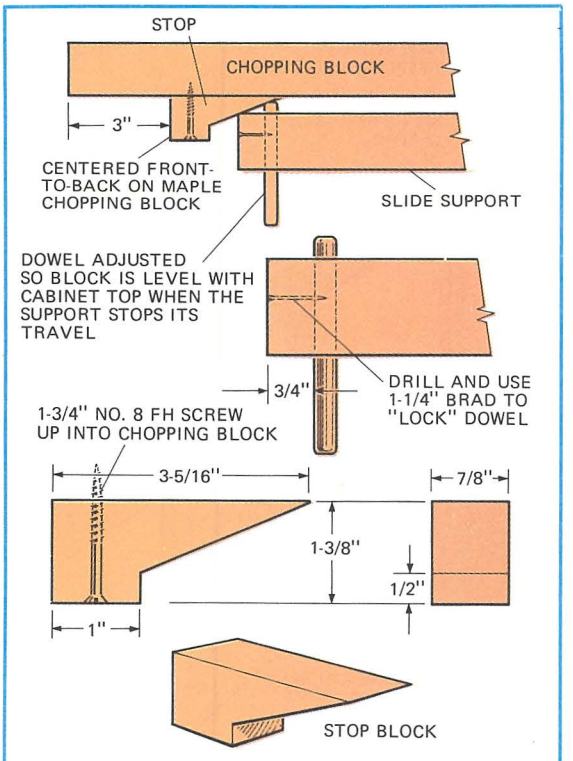


POSITION HARDWOOD STOP so slide-support assures drop leaf is level with cabinet top when extended.

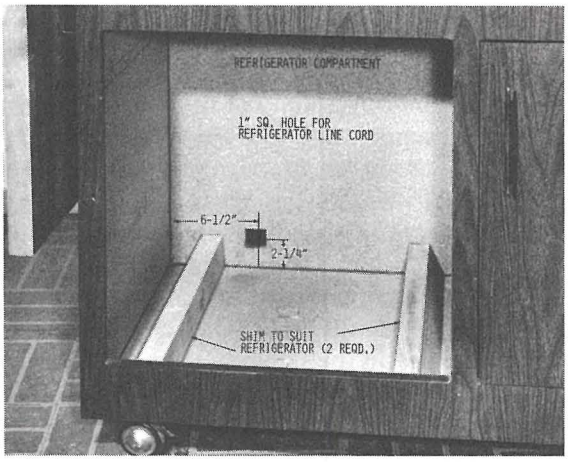
be rested on its back and the casters attached. This makes it easier to move the cart around as you advance to the finishing stages. Right the cabinet and you can go to work installing the flush-mounted storage door (after first fitting and laminating it). To keep this cart's look compatible with its matchmates, Soss hinges were used to mount the door. You could, if desired, pick a pair of flush-mount hinges that will match the door pull, but keep in mind that no such hardware was used on the other two carts (if you plan to build them).

The barbecue tools hang from 2-in. brass L-hooks. Simply lay out your set of tools as you prefer and turn the hooks into predrilled pilot holes. If your cooking-tool collection is substantial, add hooks at the right end of the cabinet.

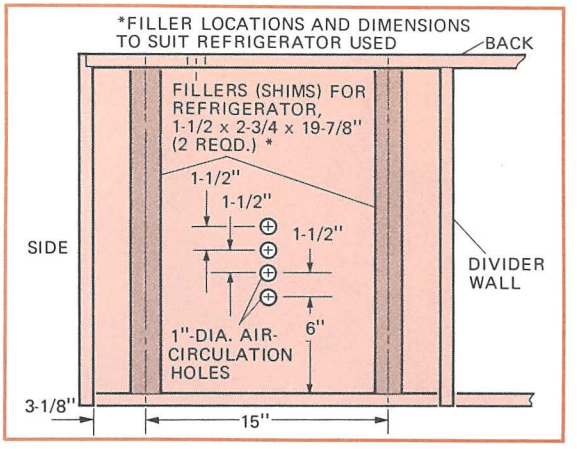
The slide supports for holding up the drop leaves look trickier to build than they actually are. Take the time to study the details in the drawings and photos. Notice that slide B inserts into slide A when both are pushed into the cabinet. You'll need four lengths of hardwood 28 in. long and four lengths 12 in. long to make the pair. After gluing up the supports, plough the



CENTER STOP AND SLIDES on maple chopping blocks. Raise and lower dowel for snug fit. When dowel is located, lock with 1¼-in. brad.



REFRIGERATOR COMPARTMENT must be sized to suit model. Size shims so refrigerator slides in and out easily—with space at top for air circulation.



ADEQUATE VENTING is a must. Drill minimum of four holes—more if you select larger-size refrigerator. Then glue and tack shims beneath.

rabbet along the length of slide B which will travel on the ½-in. square guide. You can cut a blind rabbet, but it is easier to run the full length of the slide and then add a small filler strip at the outboard end.

After making your slides, position them in the cabinet to mark the guide location. At this time also check the stop position when slides are retracted—they should stop with 3 in. projecting from the cabinet.

To locate the small triangle-shaped slide support stops, lift the first drop leaf and extend the support exactly 15 in. Note: The slide should butt the stop snugly so that the leaf is level with the top. When you have achieved this position, mark and drill for fastening the stop. Repeat the procedure on the second drop-leaf.

The final step is to install the shims (fillers) on which the refrigerator rests. They should be level with, or slightly higher than, the bottom rail so the refrigerator can be easily removed.

Manufacturers of materials

Plastic laminate, Butcherblock maple No. 204 and Gunstock Walnut No. 492, Formica Corp., 120 East 4th St., Cincinnati, OH 45202

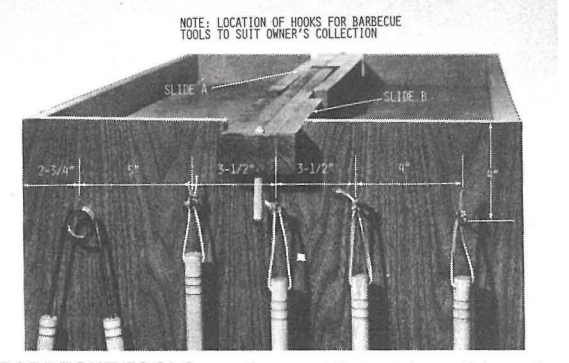
Electric barbecue; Electric Char-B-Que, New Shrewsbury, NJ 07753.

Ground fault interrupter, Model GFP-115, Harvey Hubbell, Bridgeport, CT

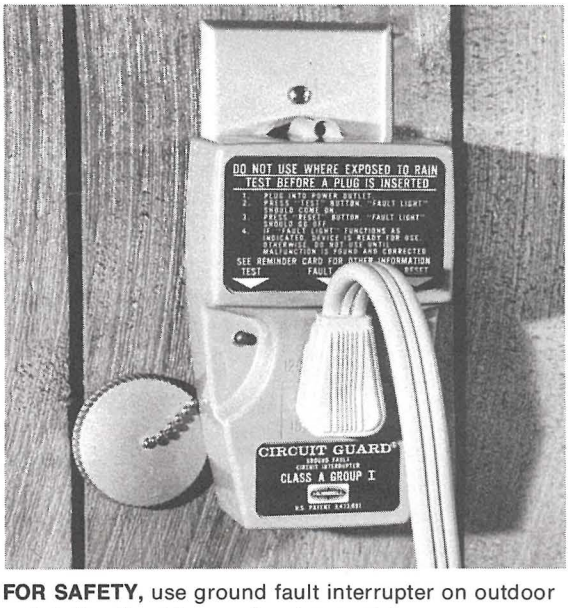
Casters; Saturn (SN) 3-in. lockable casters, Shepherd Casters, Inc., St. Joseph, MI 49085.

Refrigerator; Model 644.73872, Sears, Roebuck catalog.

Door pull; Model T 379 (AE). Amerock Corp., Rockford, IL.

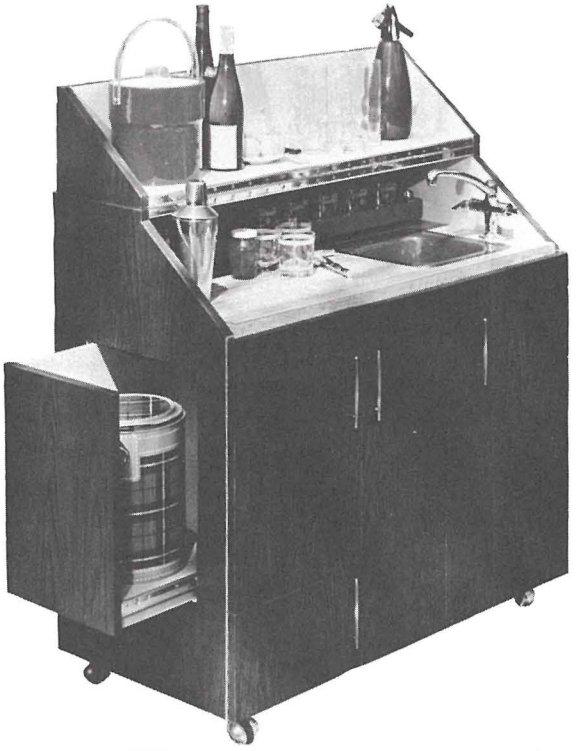


BARBECUE TOOLS are always at the ready on this cart. Hooks are spaced to suit barbecue tools.



FOR SAFETY, use ground fault interrupter on outdoor outlet. Use No. 12-ga. extension cord to power refrigerator and cooker.

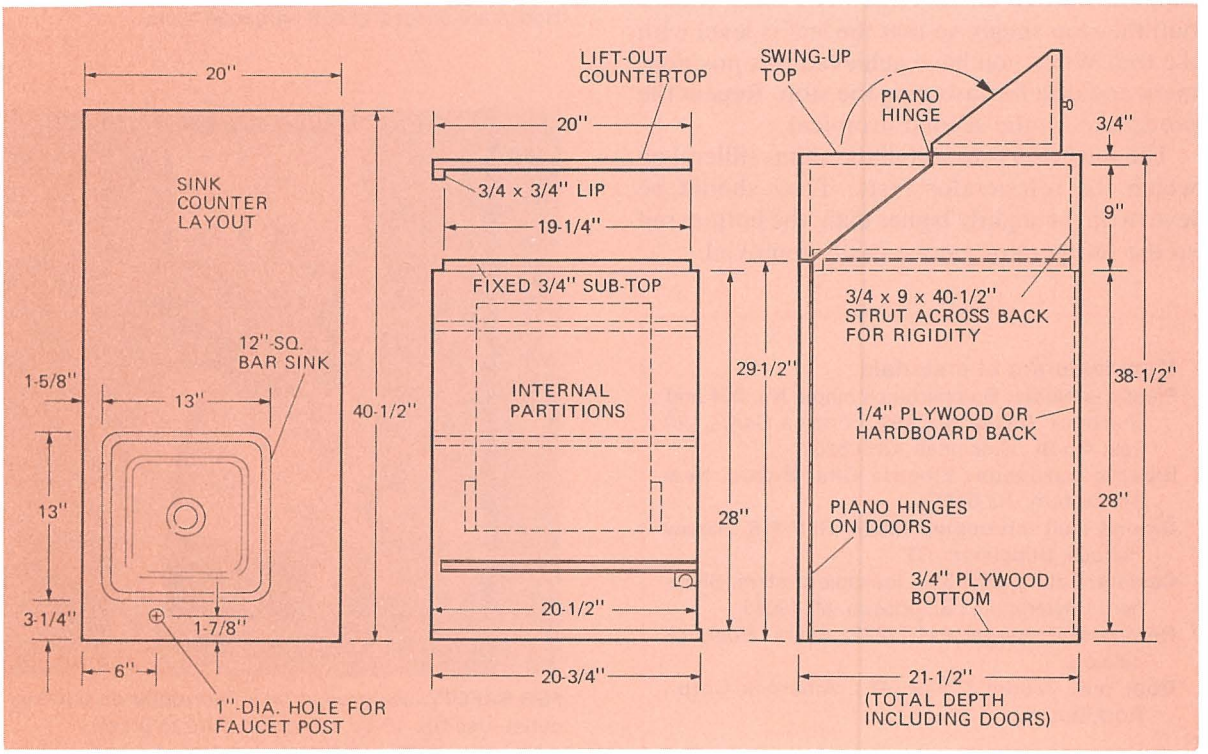
2. Roll-around wet bar with running water

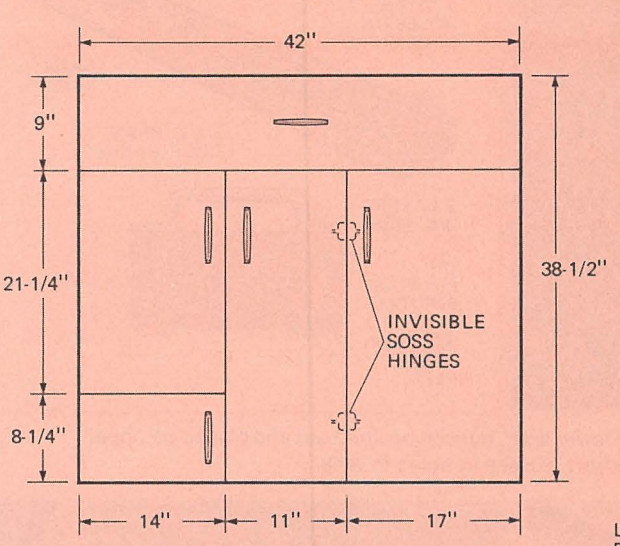


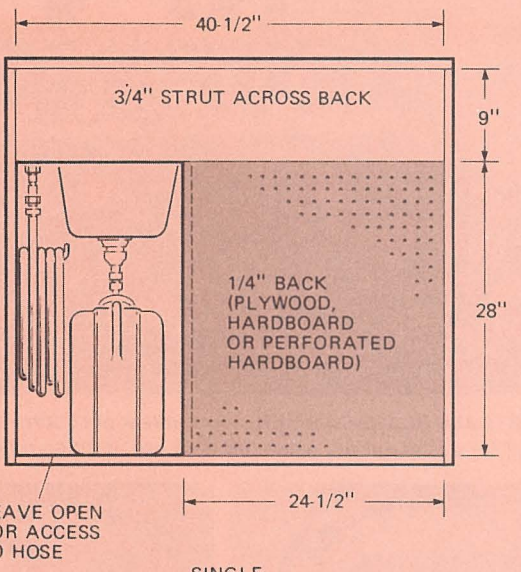
WITH TOP OPEN, bar provides a two-level work and serving counter for mixing drinks, with sink at right end on lower level. Slide-out drawer stores ice cooler, matches similar wings on the hi-fi cart.

■ YOU DON'T USUALLY EXPECT to turn on a faucet in a small home bar and really get running water—but you do with this one. Not only does the novel unit feature a built-in sink and water supply, but, like the mobile cooking center shown on the preceding pages, it's also designed for versatile, go-anywhere use—out on a deck or patio for summer entertaining or indoors in a play or family room for year-round enjoyment any time. Like the cooking center, it rolls on heavy-duty, ball-type Shepherd casters and is finished in the same exterior materials to have a similar appearance. The sink board is covered with Butcherblock Maple laminate—a Formica countertopping that so closely duplicates the look of a real wood chopping board you have to touch it to tell the difference. The top, sides and doors are faced with Gunstock Walnut—another excellent Formica pattern with deep, rich, wood-grained walnut tones.

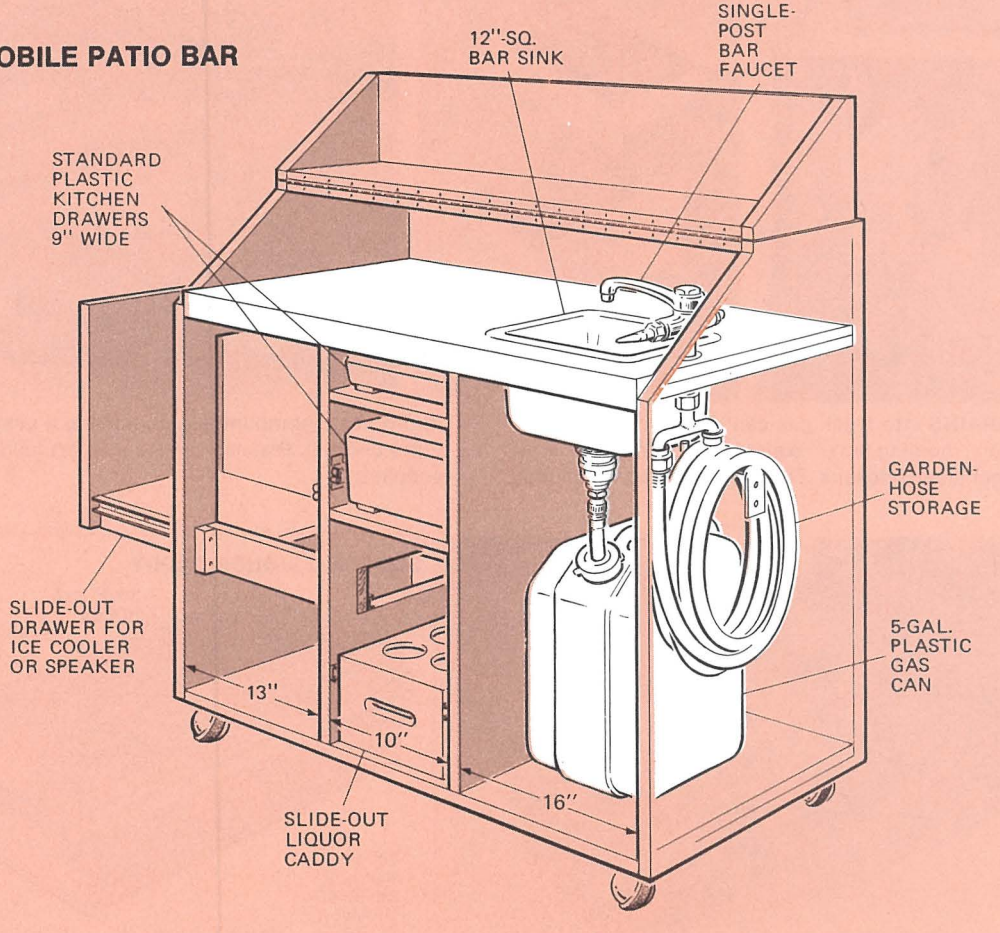
The rolling bar is designed around a trim little 12-in.-square Kohler sink with a handsome chrome single-post, pantry-type Kohler faucet. The sink comes in several striking colors—bright red, deep blue, brown and orange. We chose the red, which adds a gay, colorful, festive touch to the maple bartop and walnut exterior. The pantry-type faucet is ideal for bar use because its high-mount spigot is easy to reach under for filling drinks and rinsing glasses. The water

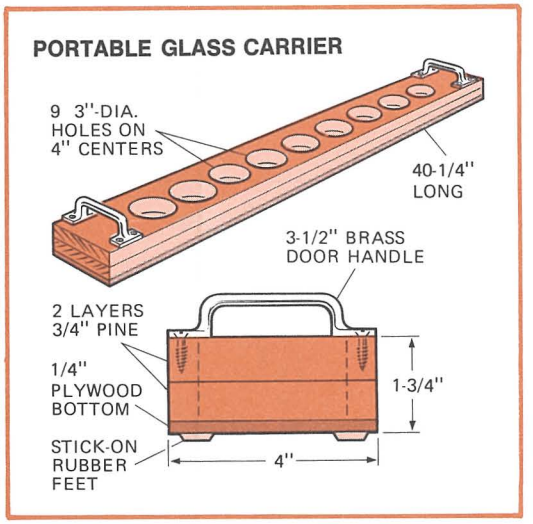




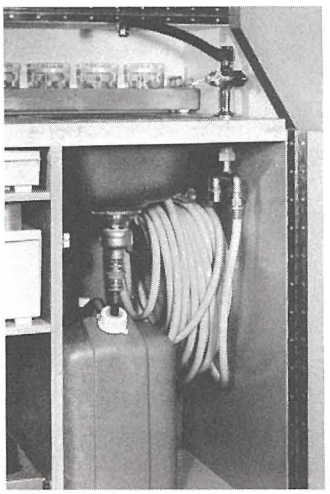


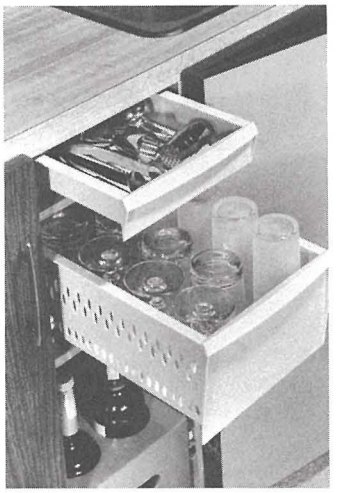
MOBILE PATIO BAR



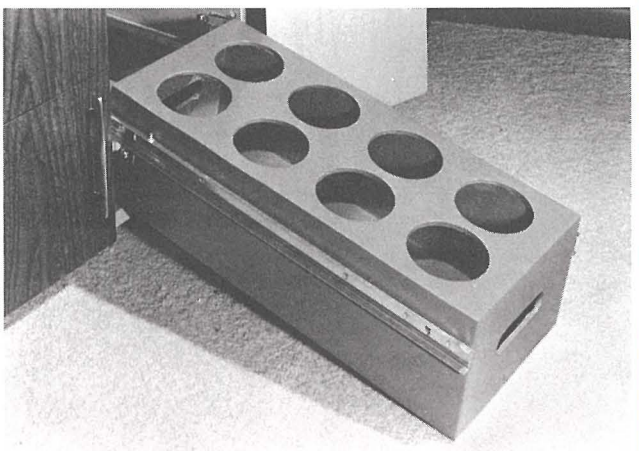


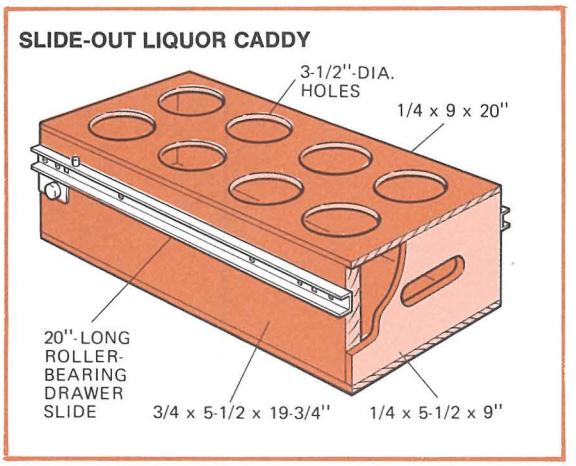
PORTABLE GLASS CARRIER stores at rear of counter on lower level, but can be lifted out and placed on upper shelf for easier access when bar is in use. It holds nine short glasses in holes in rack.



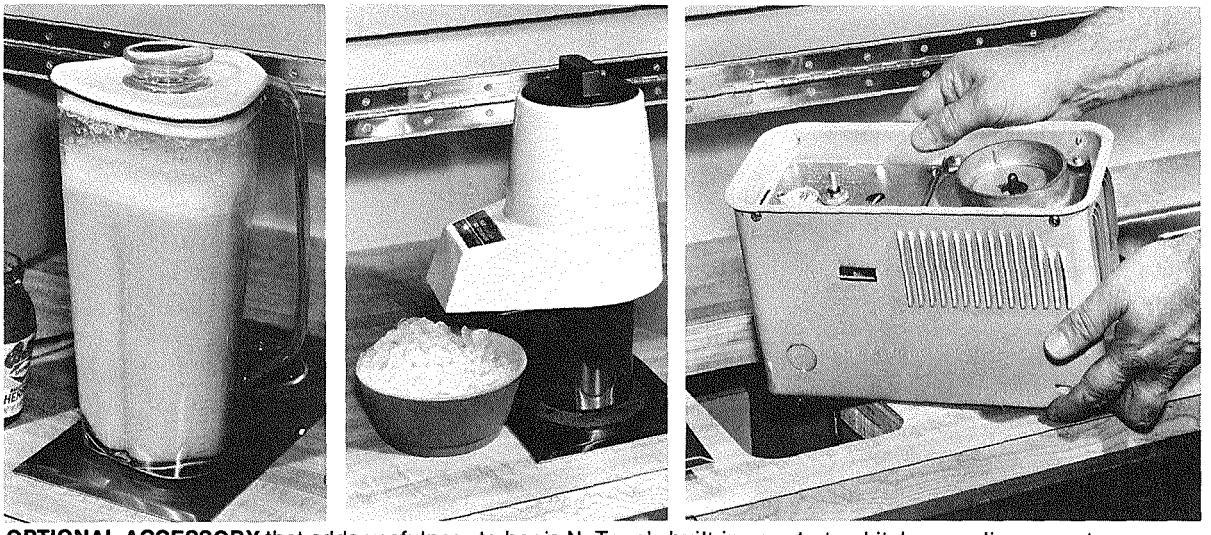


SINK DRAINS into 5-gal. gas can (left, above) used as temporary "holding tank." Water is fed from hose stored on hanger alongside tank. The single-post pantry faucet (right) has highmount spigot, making it easy to slip a glass under it. Plastic drawers (center) hold glasses, supplies.





SLIDE-OUT LIQUOR CADDY is located at bottom of the center section in cart, rolls on standard 20-in-long metal drawer guides. It is a simple box of ¼-in. plywood with ¾-in. sides. Eight 3½-in.-diameter holes in the top hold most types of liquor bottles and keep them from tipping when cart is moved.



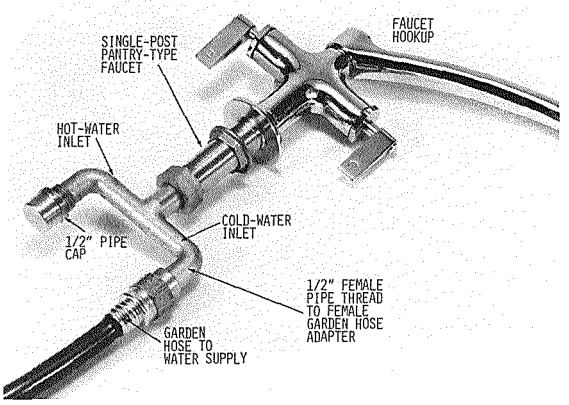
OPTIONAL ACCESSORY that adds usefulness to bar is NuTone's built-in countertop kitchen-appliance center. Motor unit recesses into counter (right), takes snap-in drink blender (left) and ice crusher (center).

hookup is simple—merely a garden hose connected to the faucet's cold-water inlet by means of a hose adapter fitting, as shown in the photo at left. To be sure the hose stays clean, buy a new one and keep it for bar use only—never use one that's been lying around the yard collecting dirt.

Indoors, the hose can be connected to a laundry tub, washing-machine filler pipe or similar water source, or you can make a semipermanent hookup with plastic pipe or copper tubing. Since hot water is rarely needed in a bar, the faucet's hot-water inlet is capped off and not used.

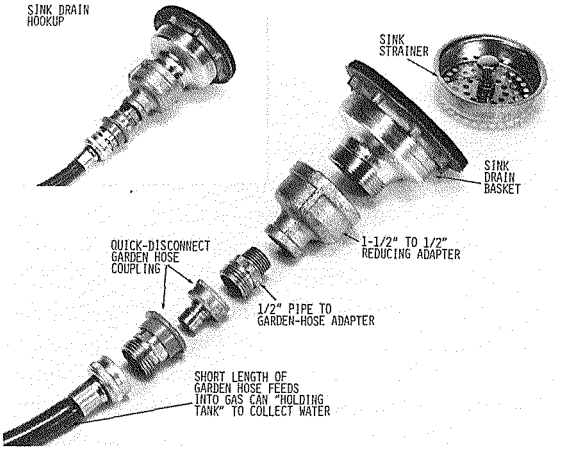
The sink drains into a five-gallon plastic gas can that serves as a "holding tank" like those used in motor homes and campers. The can easily holds the small amount of water used in the course of an evening's party and eliminates the need for complicated waste plumbing. Since nothing really dirty goes into the tank, sanitation isn't a problem. Just remember to empty its contents after each use and rinse it out to keep it clean. The can stores in a compartment under the counter and is quickly detached from the sink drain for emptying. Using a slip-type, quick-disconnect hose coupling speeds the job.

Besides the built-in sink, the mobile bar cart offers several other novel features. A hinged top swings up to form an extra serving shelf above the sink counter and closes to conceal the bar when it's not in use. There's a portable glass rack, a slide-out bin to hold an ice cooler at one end and a handy liquor caddy that stores whiskey bottles in neat, partitioned compartments to keep them from spilling when the cart is moved about.



SIMPLE FAUCET HOOKUP to garden hose is shown above, using pipe-to-hose adapter. Hot-water inlet is capped off.

SINK DRAIN requires 1½-to-½-in. pipe reducing adapter, plus garden hose coupling, to feed sink waste into tank.


SINK DRAIN HOOKUP
SINK STRAINER
SINK DRAIN BASKET
QUICK-DISCONNECT GARDEN HOSE COUPLING
1-1/2" TO 1/2" REDUCING ADAPTER
1/2" PIPE TO GARDEN-HOSE ADAPTER
SHORT LENGTH OF GARDEN HOSE FEEDS INTO GAS CAN "HOLDING TANK" TO COLLECT WATER

3. Mobile hi-fi for music outdoors or in

A suitable companion for the bar is this complete stereo system on casters. It not only contains full-size hi-fi speakers and other components but also plenty of storage space for records, tapes and supplies

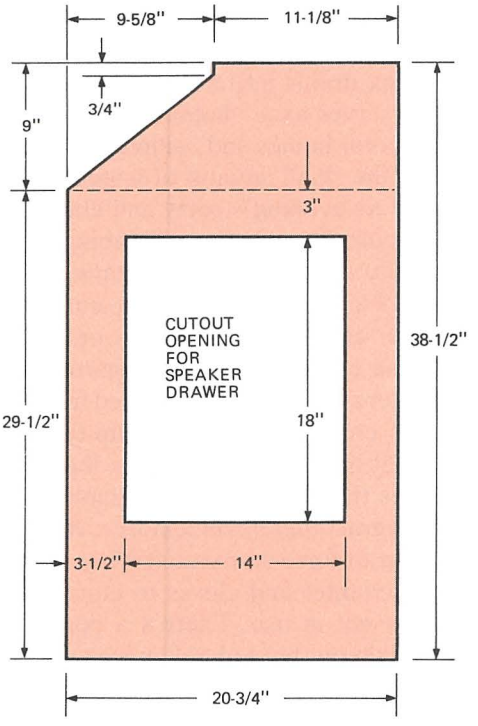
SPEAKER WINGS extend for good stereo separation and hinged top flips open to form another shelf.

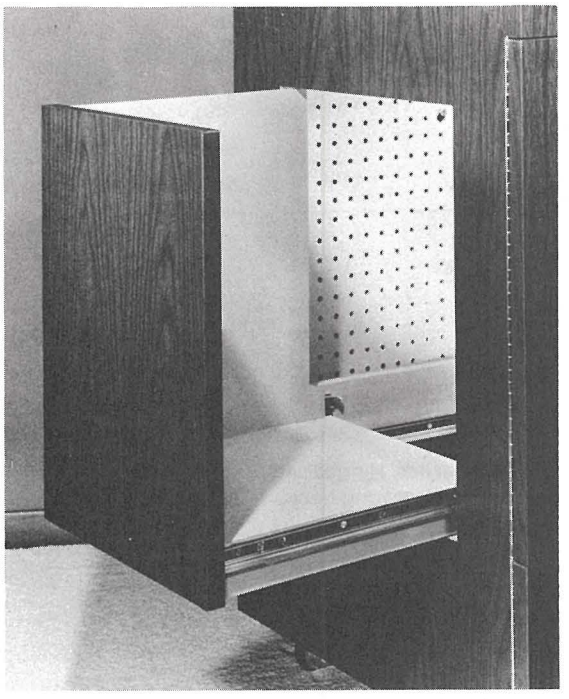
CLOSED, the mobile hi-fi becomes a stylish credenza, a "plus" in any living room.

As a companion to the bar, the identically styled mobile music center shown on the following pages makes an attractive and useful match mate. Like the bar, it rolls on 3-in. Shepherd casters for use indoors or out, has a similar hinged top to hide its contents when not in use and is finished with the same Butcherblock Maple laminate for the counter and Gunstock Walnut for the exterior. In addition, the inside of the top on both the bar and hi-fi carts is finished with Formica's Harvest Gold laminate or can be painted if you prefer. To tell how these handsome look-alike carts appear in color, see pages 2026 and 2027. Here they're shown in an outdoor

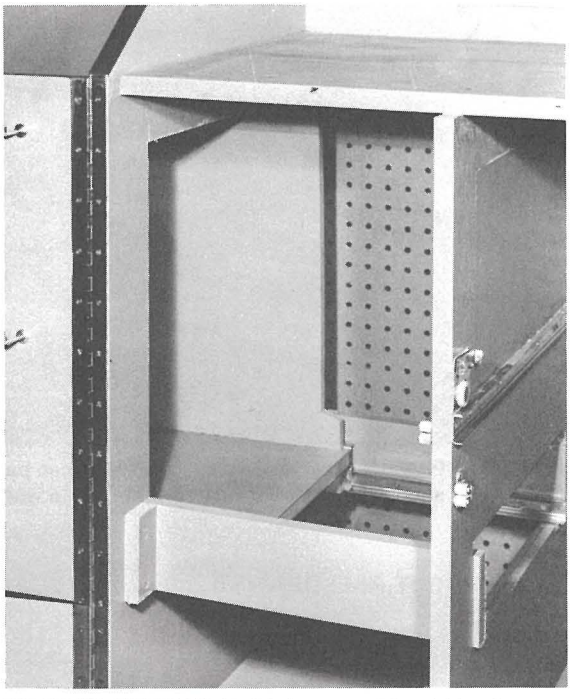
OUTSIDE END PIECES

(SAME FOR BOTH CARTS)



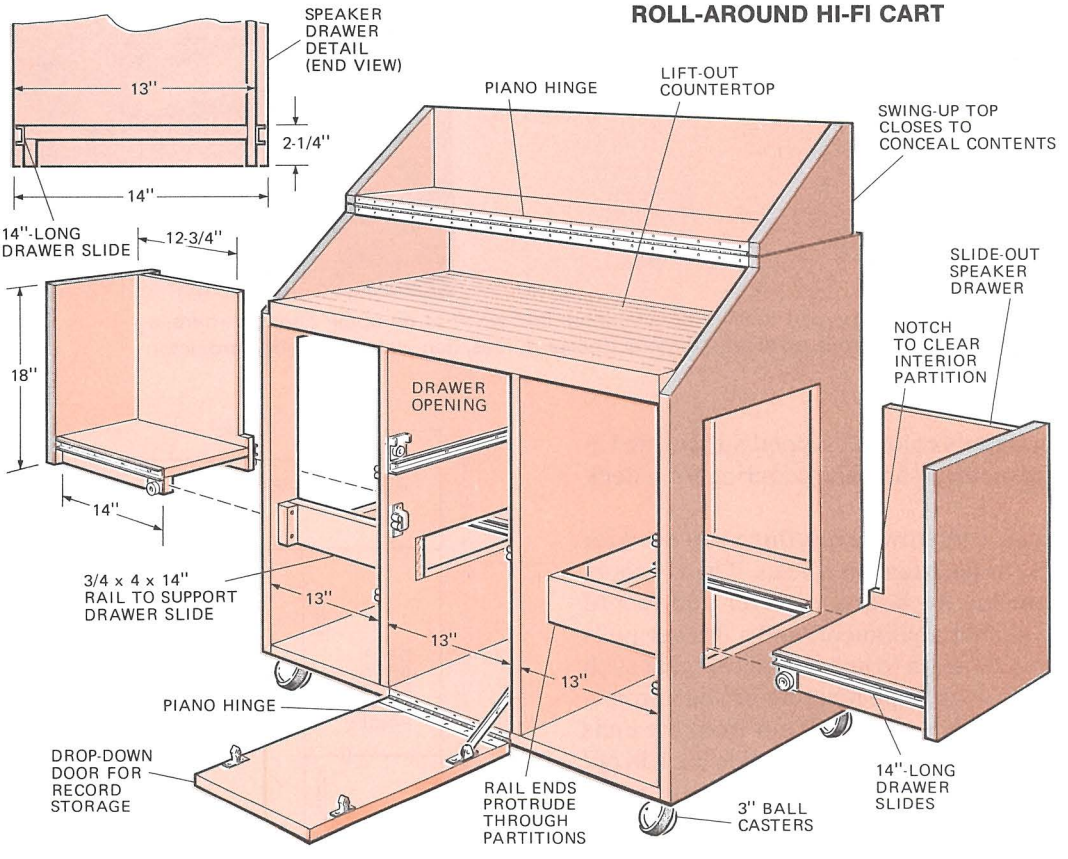


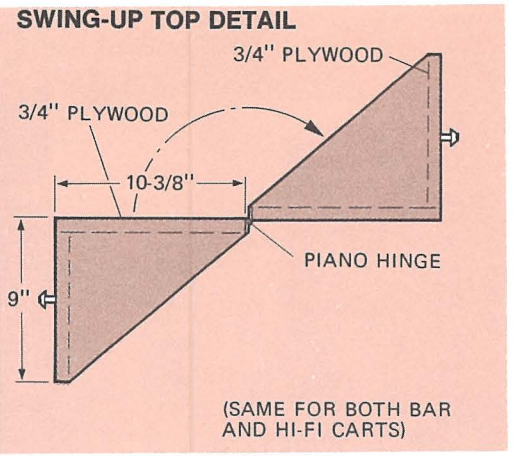
CONSTRUCTION of speaker wings is revealed here. Wings slide on drawer guides held by side rails.



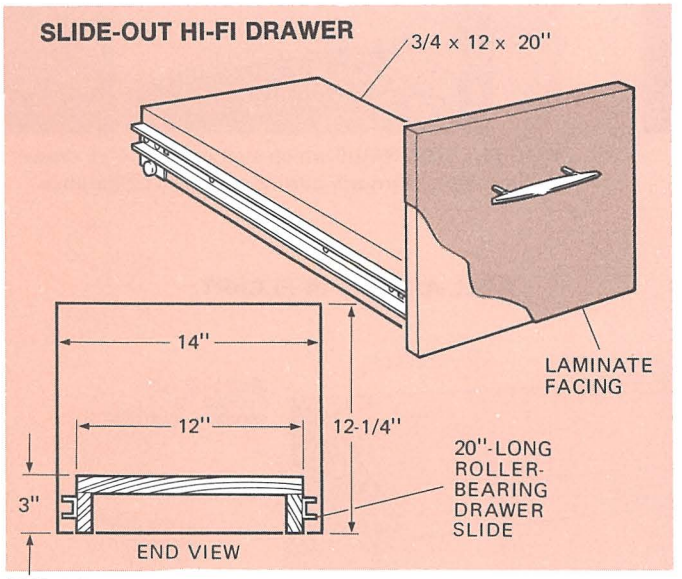
WOODEN SIDE RAILS which support the 14-in. drawer guides extend through partition for good clearance.

ROLL-AROUND HI-FI CART





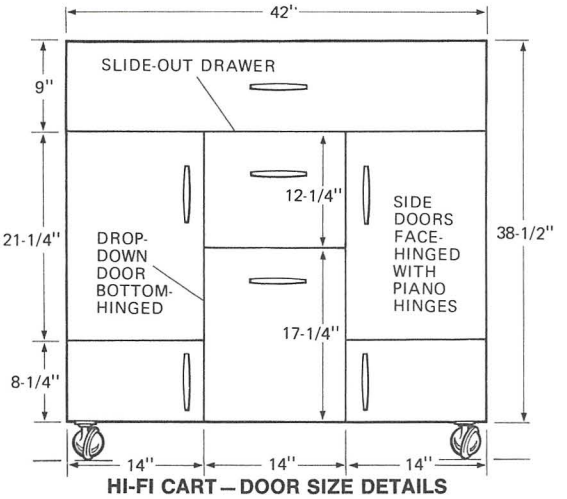
HINGED TOP swings down to conceal contents when bar or hi-fi cart is not in use. Hinged section is deliberately made ¾ in. shallower than rear half so that handle won't hit wall when top is swung back.



SLIDE-OUT DRAWER in music cart holds hi-fi equipment that won't fit on upper counter—here, a Panasonic cassette deck. It rolls on standard metal drawer guides, can also house slide projector.

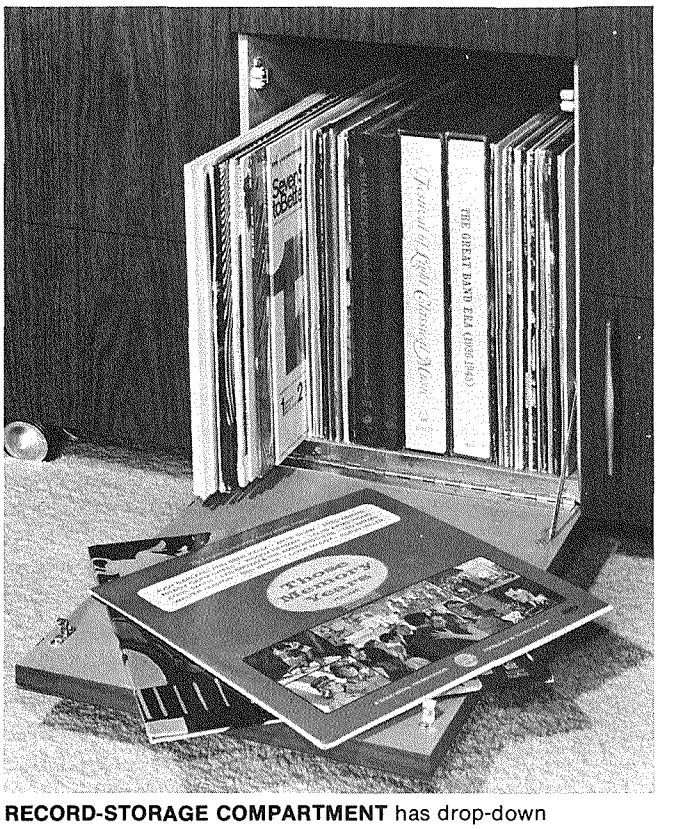
setting on Ozite's colorful, striped Sunnyside Up outdoor carpeting—an ideal covering for a deck or patio.

The music cart stows everything you need for a complete hi-fi system on wheels. There's room on the counter for both a receiver and record player or similar equipment, and a drawer pulls out from underneath to hold additional gear such as a cassette deck, tape recorder or slide projector. Twin speaker wings pull out from the ends for good stereo separation, then slide back in out of the way when they're not in use. There's also plenty of space for storing records, tapes and



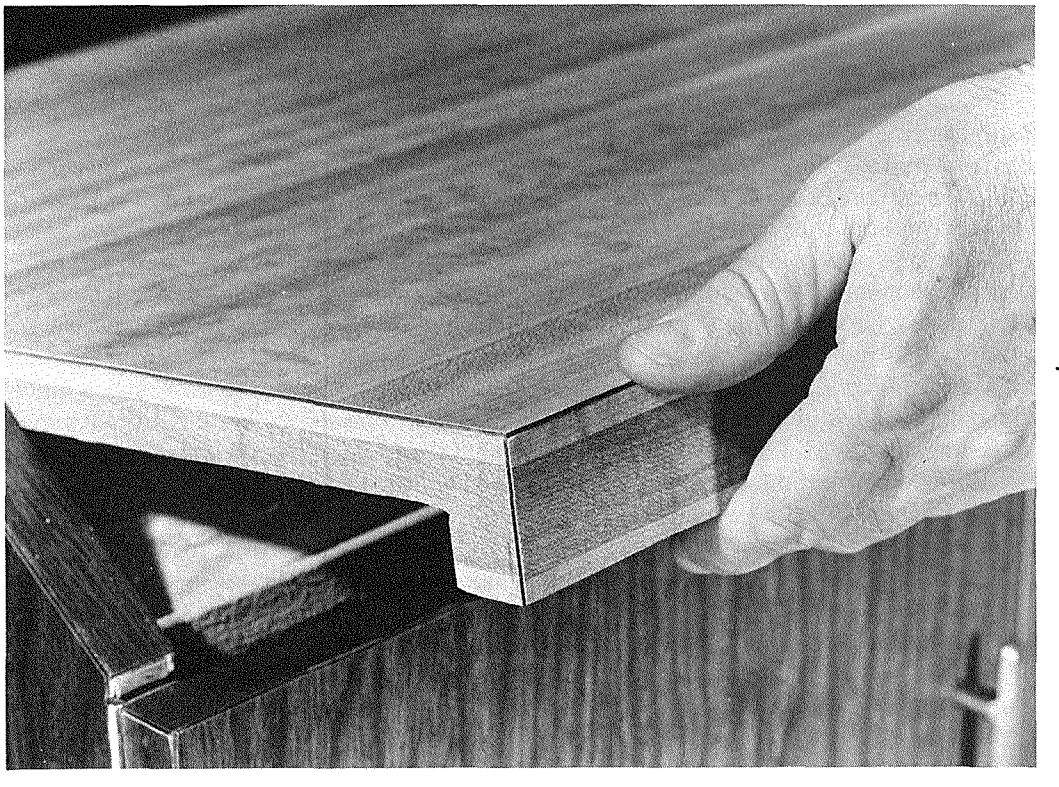
HI-FI CART—DOOR SIZE DETAILS

DRAWERS under speakers store tapes, other hi-fi and supplies. Door backs hang headphones.



RECORD-STORAGE COMPARTMENT has drop-down door that doubles as convenient shelf.

LIFT-OUT COUNTERTOP is removable for easy cleaning. Note deep lip.



continued

other supplies in drawers and compartments at the base of the cart.

To simplify construction, ready-made plastic drawers are used in several places in both the bar and music carts. These are the type made by Rubbermaid for kitchen use and are readily available in hardware and variety stores. They come in stock 9 and 12-in. widths for several dollars apiece. The carts' dimensions have been carefully worked out to accommodate these standard sizes. There's provision for two 12-in. drawers at the bottom of the hi-fi unit and one in the bar cart under the ice cooler. The bar also takes two 9-in. sizes in its center compartment for bar utensils, cocktail glasses and other supplies.

lift-out counter board

The bar and hi-fi carts are identical in construction except for the arrangement of their internal compartments. Each is 42 in. long, 21½ in. deep and 42 in. high. The basic parts are all of ¾-in. plywood with lighter ¼-in. material for the backs, either plywood or hardboard. Note that the countertop in each is actually double-thick. There's a fixed sub-top to give the cart rigidity. On top of this is a separate lift-out counter board that can be removed for easy cleaning or for replacing should the board become marred or you wish to change to a new color scheme. This lift-out top has a ¾-in.-square strip tacked across its front edge to form a 1½-in. deep lip. The lip is self-edged in the same Butcherblock Maple laminate as the top surface, giving the counter the thick, rich appearance of a real chopping block. For tips on applying the laminate, see the section on building the mobile cooking center.

The dimensions shown here are for the wood parts alone and do not take in account the extra thickness of the plastic laminate. This is done for the convenience of those who may prefer to give the carts a natural-wood or painted finish, omitting the laminate. If you decide to apply the laminate facings, slight adjustments must be made in a few of the dimensions to allow for their $^1/_{16}$-in. thickness. With one exception, the doors and swing-up tops are all face-attached with full-length piano hinges, eliminating fussy fitting and mortising. The exception is on the center door in the bar where there's no way of hinging it directly to the cart without its interfering with the door to the holding tank under the sink. To simplify matters, this door is hinged to the edge of the sink door next to it, using invisible Soss hinges. Thus, the middle door can be opened separately or both doors can be opened together for access to the tank.

There are only two tricky steps in construction—fitting the slope-sided swing-up tops and installing the slide-out speaker and ice-cooler drawers. Start by laying out the end pieces first since these determine the carts' overall shape—the rest of the parts will fall into place naturally from there. If you're building both carts, cut all four end pieces at one time—they're identical. The slide-out drawers for the speakers and ice cooler are also identical and offer a special advantage: If you want to place the two matching carts end-to-end to form one long credenza, you can use the ice-cooler drawer in the bar cart to hold the speaker normally stored in the left-hand end of the hi-fi cart. This will allow both speakers to be extended even when the carts are butted together. It will also improve stereo separation by putting the speakers farther apart. Handles on the drawers are intentionally omitted so the carts will fit flush together without any hardware to get in the way. The drawers are easily opened by reaching in and pushing them out from inside.

Standard K-V roller-bearing drawer guides are used on all slide-out parts. The speaker and ice-cooler drawers take stock 14-in. lengths, while the liquor caddy and tape-recorder drawer need longer 20-in. sizes. These metal tracks require a ½-in. clearance on each side so make the drawers an inch narrower than the openings into which they fit. The ready-made Rubbermaid drawers come with their own plastic slides and are easily mounted with four screws in each.

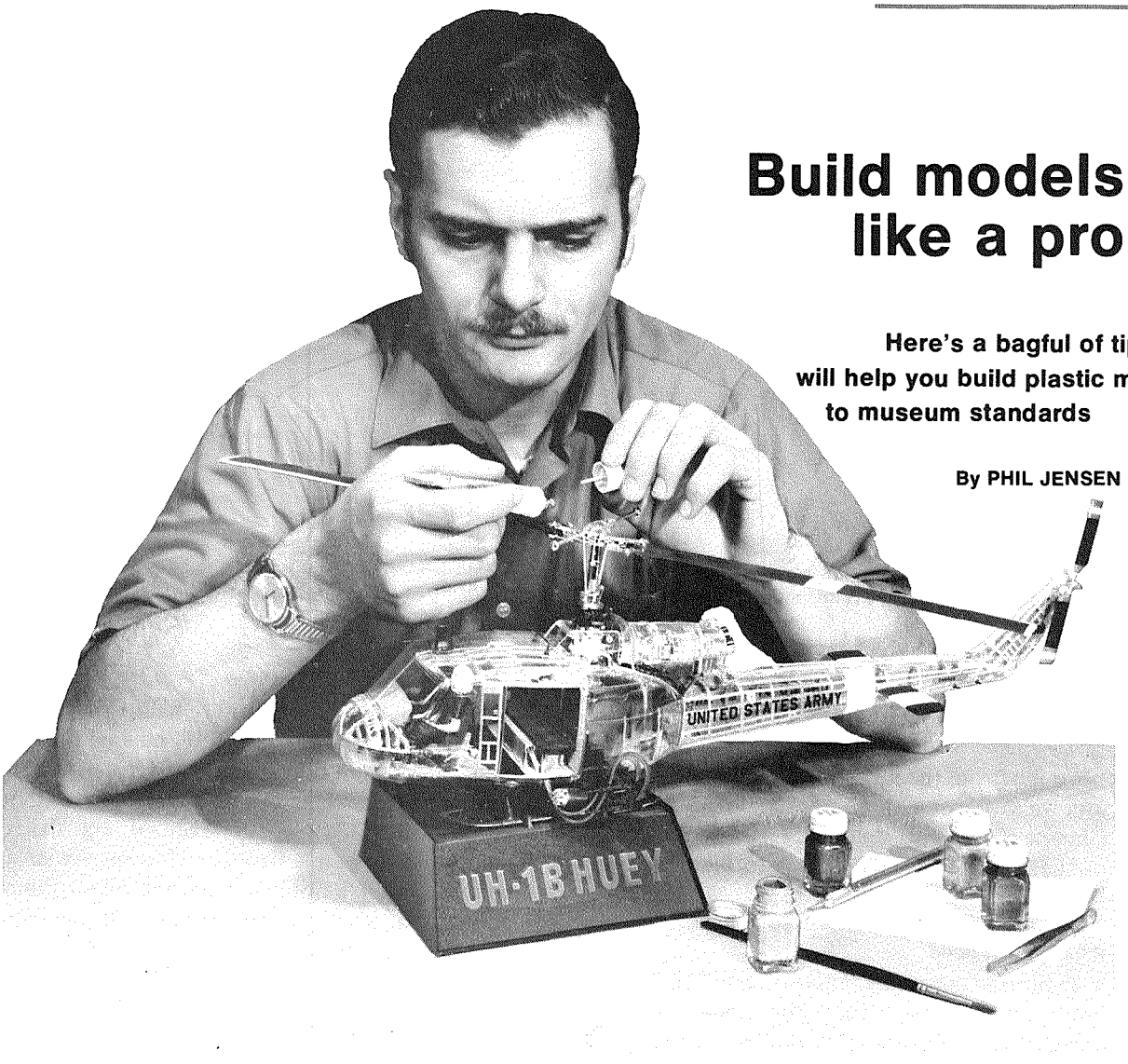
plumbing facts

The 12-in. sink used in the bar cart is Kohler's Addison Model K-6550. The pantry-type faucet is the Simplex Model K-7890. These are available at plumbing-supply dealers. If you have difficulty locating one in your area, write the Kohler Co., Kohler, WI 53044, for information on local sources. If you should select a faucet other than the one shown here, be sure it stands no higher than 7 in. above the top of the counter. This is maximum height to allow adequate clearance for the top to swing down over the faucet without hitting it. Note that the faucet is mounted off-center to the sink, close to the front edge of the counter. This makes it more readily accessible and gets it out from under the overhanging shelf above. All handles on both carts are straight modern pulls in antique brass finish and match the one on the mobile cook-center. They're Amerock Model No. T-379.

Build models like a pro

Here's a bagful of tips that will help you build plastic models to museum standards

By PHIL JENSEN

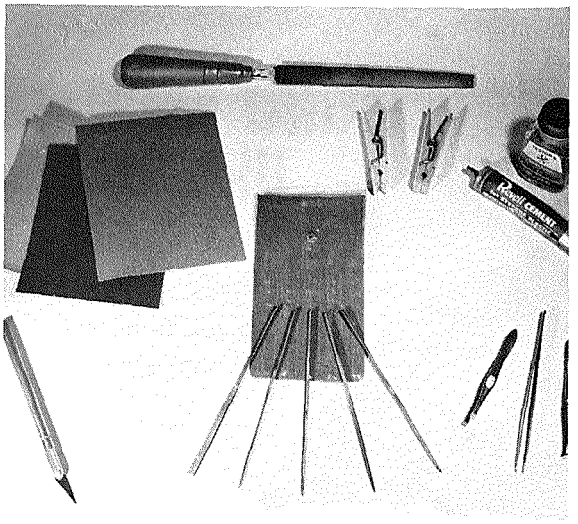


■ FOR MORE THAN two decades, plastic kits have been quietly revolutionizing the hobby of model building. Time was when the hobbyist who wanted to recreate in miniature any object from the world around him, had to be a highly skilled craftsman and possess an extensive collection of hand and power tools. Now, however, almost anyone can walk into a store, purchase a kit, and in a few hours turn it into an acceptable model of anything from an antique car to the latest Detroit hot rod, from a Roman bireme to the nuclear-powered aircraft carrier USS *Enterprise*, from the Wright Brothers' frail biplane to the Apollo 11 spacecraft or a supersonic transport.

Early kits were quite crude and often difficult to assemble, but today's kits are made of top-quality materials with parts carefully engineered for ease of assembly. With a little extra care during assembly, a plastic model becomes a masterpiece.

SEE ALSO

Airplane models . . . Cannon models . . . Hobby centers . . . Jeweler's saws . . . Ship models . . . Tool carriers . . . Tools, hand



TOOLS NEEDED include knife, jeweler's files, tweezers, sandpaper, emery cloth, clothespins and cement.

NAME-BRAND ENAMELS are the best bet when choosing a finish. Suitable brushes for details are shown.

continued from previous page

To illustrate the steps necessary for a perfect job, we've chosen Monogram's "Phantom Huey Chopper," a highly detailed, 1/24th-scale replica of the Army Bell UH-1B gas-turbine-powered helicopter.

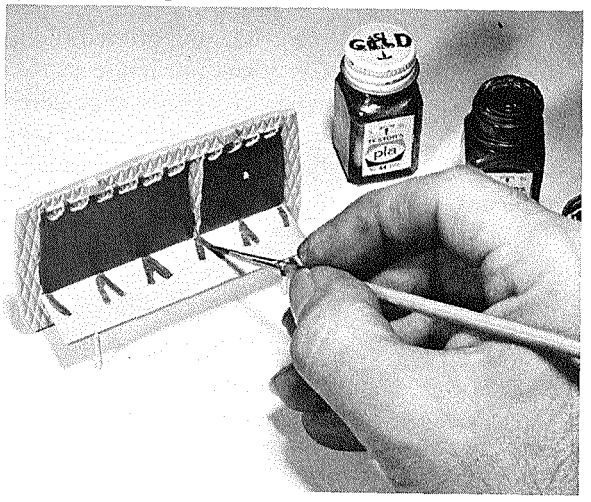
what you'll need

• *Tools and materials*. Have on hand an X-Acto knife, set of jeweler's files, 8-in. fine-cut mill file and several tweezers. You'll also need medium and fine sandpaper or emery cloth for smoothing rough spots, spring-type clothespins and rubber bands for "clamping" and, if the model includes decals, small scissors. Be sure to buy the cement made for styrene plastics. It comes as a liquid, either in a small bottle with applicator brush in the cap or in a tube. The latter seems to be thicker, thus allows better control, and the resulting joint seems stronger. It's also wise to have a small amount of automobile rubbing compound. If you get cement on a finished surface or clear plastic part, the damage can be rubbed out.

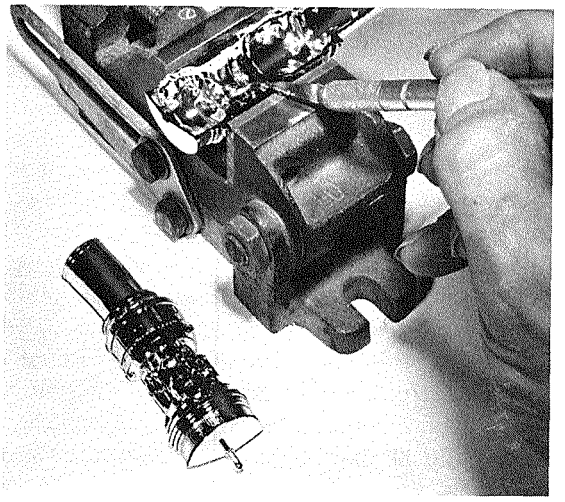
understand each step

• *Preassembly instructions*. Most instructions recommend that you study all steps before starting. However, it's more important that you un-

WATCH FOR PARTS, such as seat belts, that should be painted although not so mentioned in the instructions.

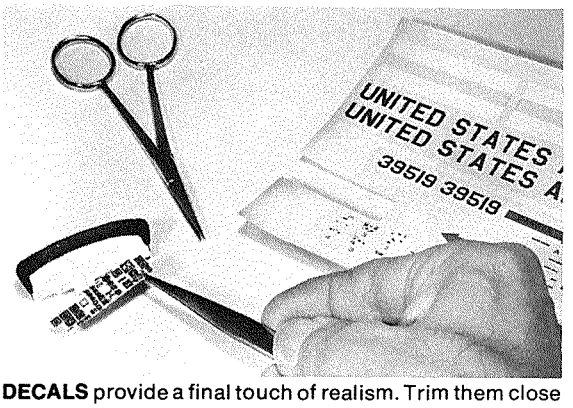


SCRAPE "CHROME" from all surfaces to be joined. Both halves of the detailed jet engine are scraped here.



derstand *each* step before proceeding. Then you can locate and identify the needed pieces. In top-quality kits, parts are usually identified by numbers molded into the parts or adjoining mold-runner and corresponding to those shown in the instructions.

As you proceed, cut each part loose from the runner and examine it for imperfections. Look for flash, ridges at the mold parting-lines and sinkholes in the surface over the heavy sections. Carefully trim flash and ridges with your knife, then sand, file and polish the surface until smooth. Sinkholes are more difficult. Usually the surrounding surface can be filed until the hole disappears. Again, follow up with sanding and polishing. Plastic putty, available in hobby shops, can be used to fill sinks, but the part must then be primed and painted.



DECALS provide a final touch of realism. Trim them close to the actual pattern so unsightly edges don't remain. A handkerchief is ideal for smoothing them. If a decal sticks before it's in place, lift it off with tweezers, dip it in water and reposition. When the decal is dry, rub it lightly to give it a sheen.

spray-paint before assembly

• *Paint as you go.* Spray-paint all large parts before assembly. If this isn't possible (as with auto hoods, trunk lids and doors), tape the parts together on the inside so they all turn out the same shade. For two-tone paint jobs, always paint the lighter tone first. When it's *thoroughly* dry, cover the area to remain that color with masking tape. Press tape edges tightly against the surface to prevent the second color from bleeding onto the first.

Detail painting can be done before or after the part is in place. For example, if you paint a small part in another color than that of the large part to which it will be cemented, you can attach and brushpaint it in place.

• *"Chrome" plating.* Actually an extremely thin layer of aluminum (deposited in a vacuum) plating is easily damaged by careless handling. Thin as it is, this metallic layer interferes with proper cementing and must be scraped or filed away. Be careful to remove just the unwanted chrome; once it's removed you cannot replace it.

In some cases you may decide the manufacturer has gone chrome-happy and plated parts shouldn't have this shiny finish. Paint may be applied directly over chrome but, according to Monogram, it's better to remove all plating from parts by soaking in flux (zinc chloride). Next day, wash them in clear water and allow to dry. This treatment does not harm the plastic but provides a superior surface for model enamels.

• *Assembly.* The important points are:

1. Check each part for position and proper fit before applying cement. Locating pegs may be oversize, surfaces may not meet exactly or a missed piece of flash may prevent flush mounting. Use your knife and a small file to rectify these conditions.

2. Apply only a minimum of cement, especially on clear plastic parts. For the strongest bond, apply a thin coat of cement to parts to be joined, allow to dry a few minutes and then press them together. Hold the parts until the joint sets, or use rubber bands or clothespins as clamps. Should any cement squeeze out, *do not* try to wipe it away. Let it harden thoroughly and then scrape it away with your knife. Repair any damaged surface with sanding and polishing.

don't force parts

3. Never try to force parts together. Even the best, high-impact styrene is easily broken. But if you do happen to break a part, don't despair. Cracks in large parts can be repaired by cementing; smaller parts such as axles or ship masts, should be reinforced. Drill both ends of the break to receive a short piece of common pin, apply cement and press them together. Allow plenty of time to harden completely.

• *Finishing touches.* Unless parts will get in the way, apply decals after the model is painted and assembled. Trim as shown and follow instructions for applying. Use a smooth cloth to smooth and rub out air bubbles to the edges.

Touch-up painting is a last step. Small imperfections in chrome can be repaired with aluminum paint, but don't overdo it.

The important tip is to *take your time.* If you find yourself tiring, just put the model away and go back to it after a couple of days.

Modelmaker's shop in a cabinet

By RUDY KOUHOUPT

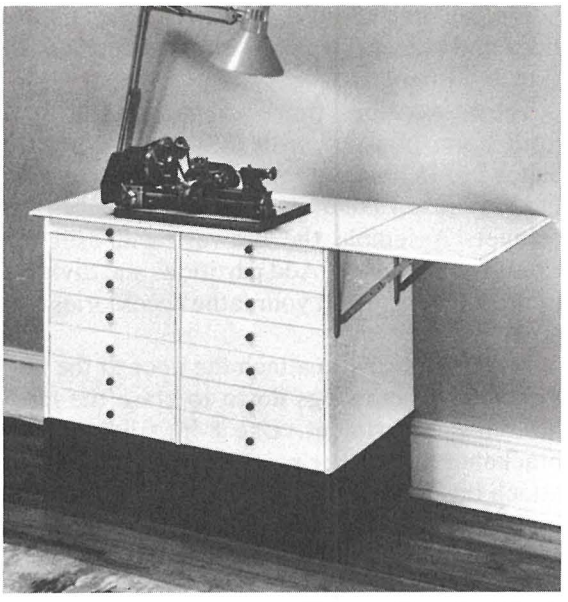
■ IF YOU NEED a good place to work on miniature engines, models or other small projects, this neat little cabinet will fill the bill nicely. It's an efficient and inexpensive cabinet workshop that takes up just 3½ sq. ft. of floor space and provides a place for everything. And your metal lathe, vise and large tools can be stored in the roomy bottom compartment between work sessions. Fourteen shallow drawers place all hand tools, lathe accessories and measuring devices at your fingertips. You will have more than enough bench space when you raise the hinged drop leaf to obtain the full 17 x 44-in. work surface.

All members of the cabinet are cut from ½-in. plywood and are fastened together with glue and brads. Start with the sides which are 16¾ x 26½-in. Dado the sides 7 in. from the bottom so the shelf will be well supported. Scribe and cut the sides to clear your baseboard when the cabinet is against the wall. Fasten the 16 x 29¼-in. shelf in the dadoes in the sides and use a length of dowel in front to give center support to the shelf.

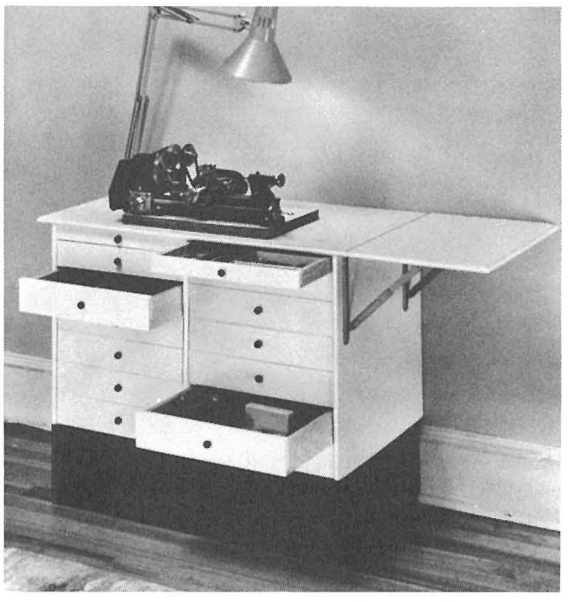
The center divider is attached to the top of the shelf. Cut a piece 17 x 32 in. for the top. Put it in place nailing into the sides and center divider. Use a 4-in. triangle of ½-in. plywood at each corner in the rear to reinforce the shelf, sides, top and center divider.

Cover the exposed edges of the plywood with ½-in. half-round molding for appearance. Rip

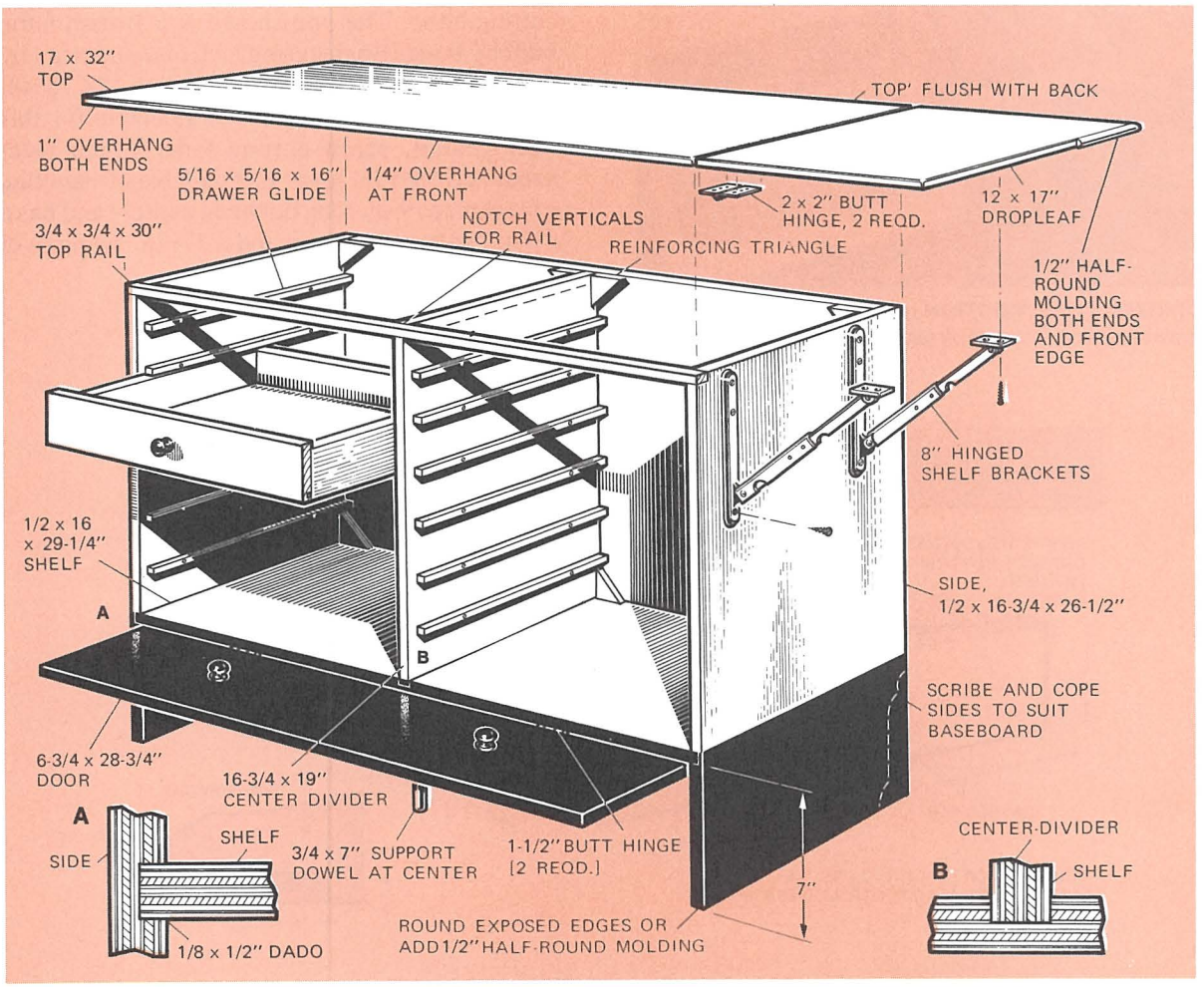
SEE ALSO
Airplane models . . . Apartment workshops . . . Cannon models . . . Drawers . . . Hobby centers . . . Ship models . . . Tools, hand . . . Workbenches . . . Workshops

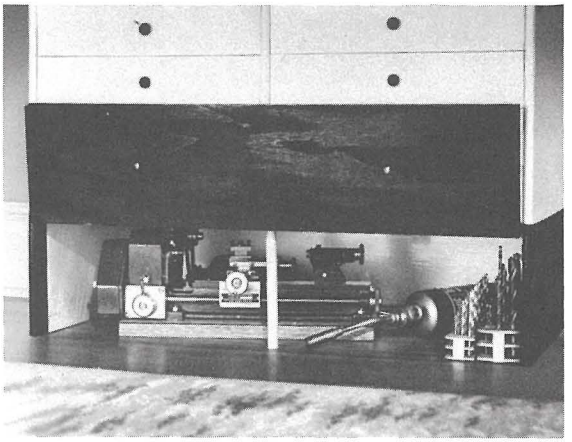


IF FINISHED NEATLY, your cabinet workbench will look well in just about any room where you keep it.

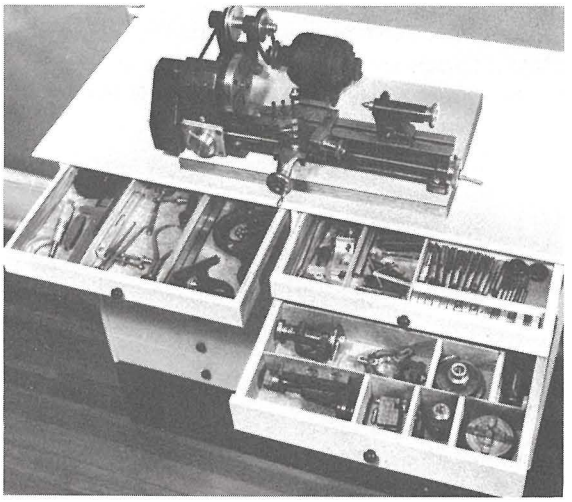


SMALL TOOLS and lathe accessories are at hand in shallow drawers. Use thin wood for drawer partitions.


17 x 32" TOP
TOP' FLUSH WITH BACK
1" OVERHANG BOTH ENDS
5/16 x 5/16 x 16" DRAWER GLIDE
1/4" OVERHANG AT FRONT
2 x 2" BUTT HINGE, 2 REQD.
12 x 17" DROPLEAF
3/4 x 3/4 x 30" TOP RAIL
NOTCH VERTICALS FOR RAIL
REINFORCING TRIANGLE
1/2" HALF-ROUND MOLDING BOTH ENDS AND FRONT EDGE
8" HINGED SHELF BRACKETS
1/2 x 16 x 29-1/4" SHELF
A
B
SIDE, 1/2 x 16-3/4 x 26-1/2"
SCRIBE AND COPE SIDES TO SUIT BASEBOARD
6-3/4 x 28-3/4" DOOR
16-3/4 x 19" CENTER DIVIDER
A
SIDE
SHELF
3/4 x 7" SUPPORT DOWEL AT CENTER
1-1/2" BUTT HINGE [2 REQD.]
1/8 x 1/2" DADO
ROUND EXPOSED EDGES OR ADD 1/2" HALF-ROUND MOLDING
7"
CENTER-DIVIDER
B
SHELF



SMALL PERRIS LATHE (18½ in. long) is quickly and easily stored out of view behind the hinged door on bottom.



DRAWER CONSTRUCTION is simple as shown in the drawing below. Partitions (above) suit the owner's tools.

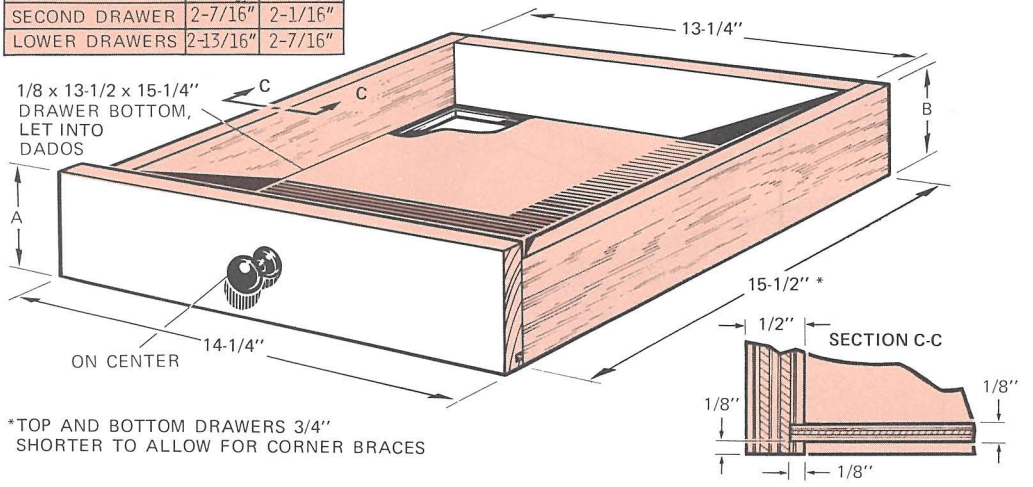
$^{5}/_{16}$-in.-sq. strips to use as drawer slides on the sides and center divider. Fasten the strips with glue and brads.

The drawer sides, fronts and backs are also cut from ½-in. plywood with a ⅛ x ⅛-in. groove dadoed in ⅛ in. from the lower edge to receive the bottoms. Take drawer dimensions from the cabinet. Assemble the drawers and drill the fronts for the knobs. Add partitions and dividers to the drawers to suit your lathe accessories and tools.

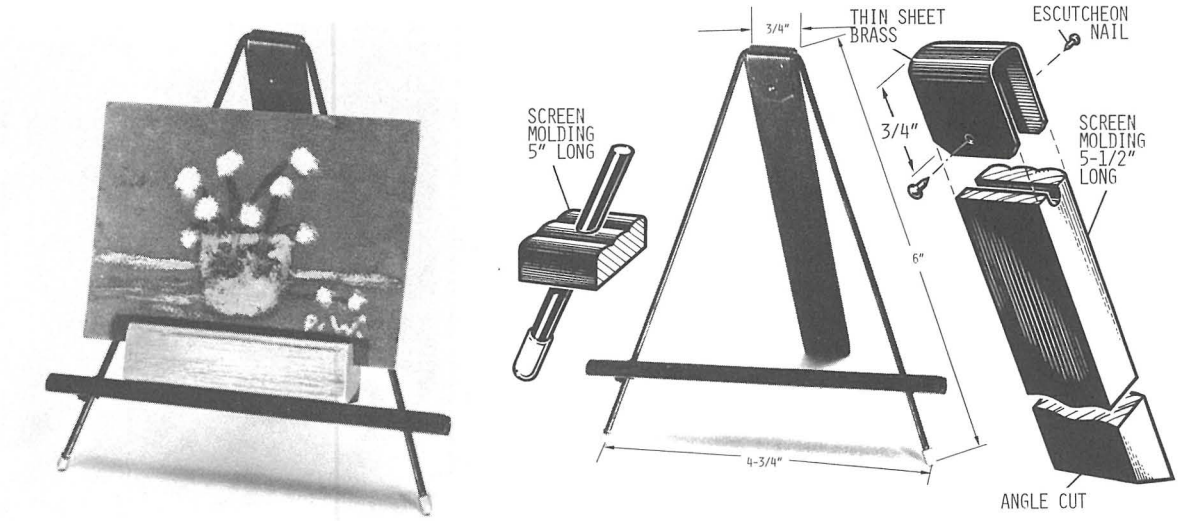
Use butt hinges to attach the door to the bottom shelf so it swings down to close the large bottom compartment. Use 8-in. folding shelf brackets and another pair of butts as shown to attach the drop leaf. Put ½-in. half-round molding around the top and drop leaf. If you have the space, a drop leaf could be fitted to the other end also. Cover the top and drop leaf with plastic laminate. The cabinet receives a coat of enamel undercoater followed by a durable semigloss enamel.

Modelmakers who build engines and similar projects will require the use of a small metal-cutting lathe. The one shown is a British lathe built by Perris Engineering Ltd. and imported by Caldwell Industries, Box 170, Luling, TX 78648. A full range of accessories is available for this back-geared, screw-cutting lathe which measures just 18½-in. long. It is capable of handling a workpiece 9-in. long between centers and has a 4¾-in. swing in the gap and a 3½-in. swing over the bed.

	A	B
TOP DRAWER	1-7/16"	1-1/16"
SECOND DRAWER	2-7/16"	2-1/16"
LOWER DRAWERS	2-13/16"	2-7/16"

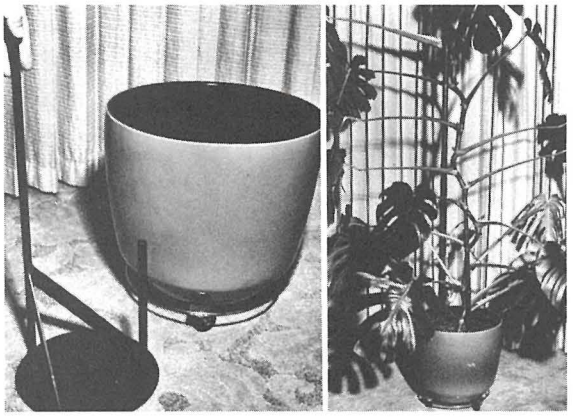


*TOP AND BOTTOM DRAWERS 3/4" SHORTER TO ALLOW FOR CORNER BRACES



MINIATURE EASELS will attractively display objects such as nameplates and postcard paintings. These easels can easily be mass-produced using screen molding, coathanger wire and sheet brass. The easel's support leg is hinged with a U-shaped clip so that the leg can be adjusted to the desired angle. Holes for the wire should be drilled to fit tightly. When not in use, the easel can be folded flat.—*Henry Stainken, Staten Island, NY.*

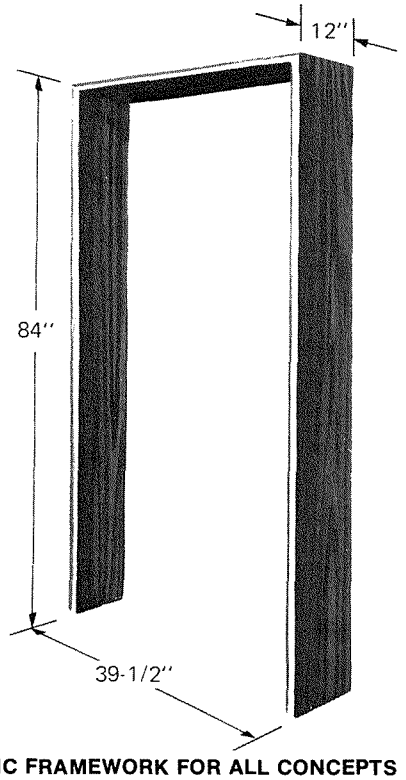
A FELT-TIP marking pen makes a good substitute for regular layout dye when you need to mark and inscribe metal. You can scribe it when it dries and it will wipe off easily with a lacquer thinner.—*Doug Blodgett, St. Charles, MO.*



A STRONG SUPPORT rod for unwieldy plants is a real necessity, especially when soil in the pot won't hold a stake. For my tall philodendron, I welded three metal rods (one 24-in., the others 12-in.) to an 8-in.-dia. steel plate as shown above, removed the plant from the pot, put the welded plate in the bottom and repotted the plant. I stuck lengths of bamboo fishing pole over pointed ends of the rods and changed to longer lengths as the plant grew.—*G. H. Willard, Seattle.*

Easy-build modular furniture

Starting with one basic frame, you can create five different pieces. They all have efficient, built-in lighting to suit many tasks



BASIC FRAMEWORK FOR ALL CONCEPTS

ROOM DIVIDER is simplest of five handsome furniture pieces. It's accented by reflector lamps at the top.

■ THE CHALLENGE: Create a versatile module that can be used in almost any room for any purpose and lighted to suit the particular function the piece is designed for. Designer Bill Ingham at General Electric fielded the challenge and came up with a series of good-looking furniture pieces including the handsome room divider shown.

The basic form with its standardized dimensions can be quickly adapted to serve any number of family needs. The five most common uses are you wish to build. The idea is to get the most use from a minimal amount of space—essentially a simple enclosure measuring a foot in depth, 39½ inches in width and 84 inches in height.

The material to use on this project is ¾-in. A-D plywood. And stick to the very basic construction techniques. Simply use butt joints, glue and screws. Finishing the various pieces is a matter of personal preference. They can be painted, stained if a cabinet-grade plywood is used, or covered with plastic laminate. Or the units can be finished using a combination of two or more finishes.

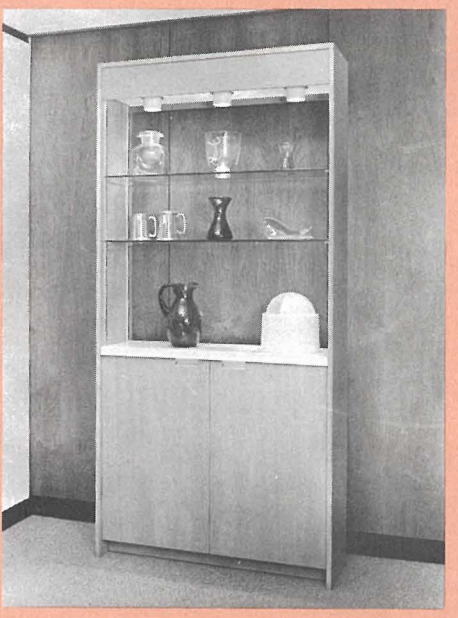
SEE ALSO

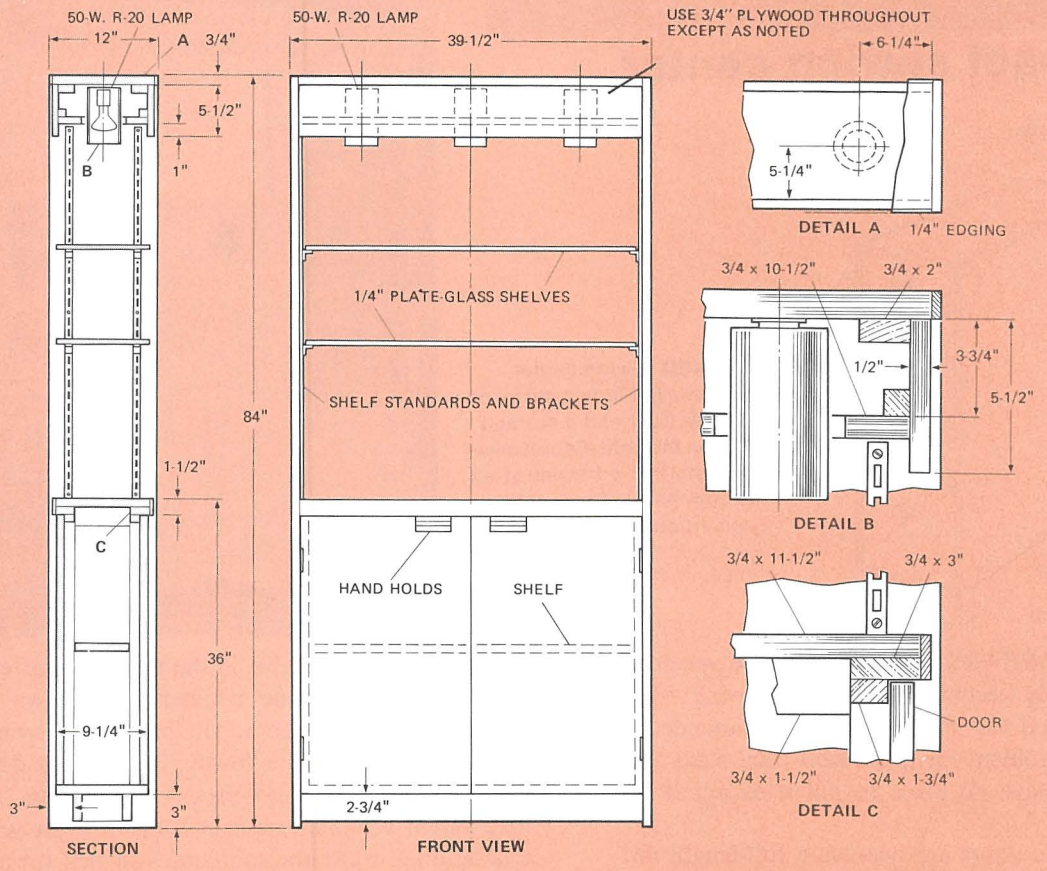
Ceilings . . . Doors . . . Finishes, wood . . . Frames, art . . . Joinery . . . Picture frames . . . Remodeling ideas . . . Sanding . . . Staining, wood . . .

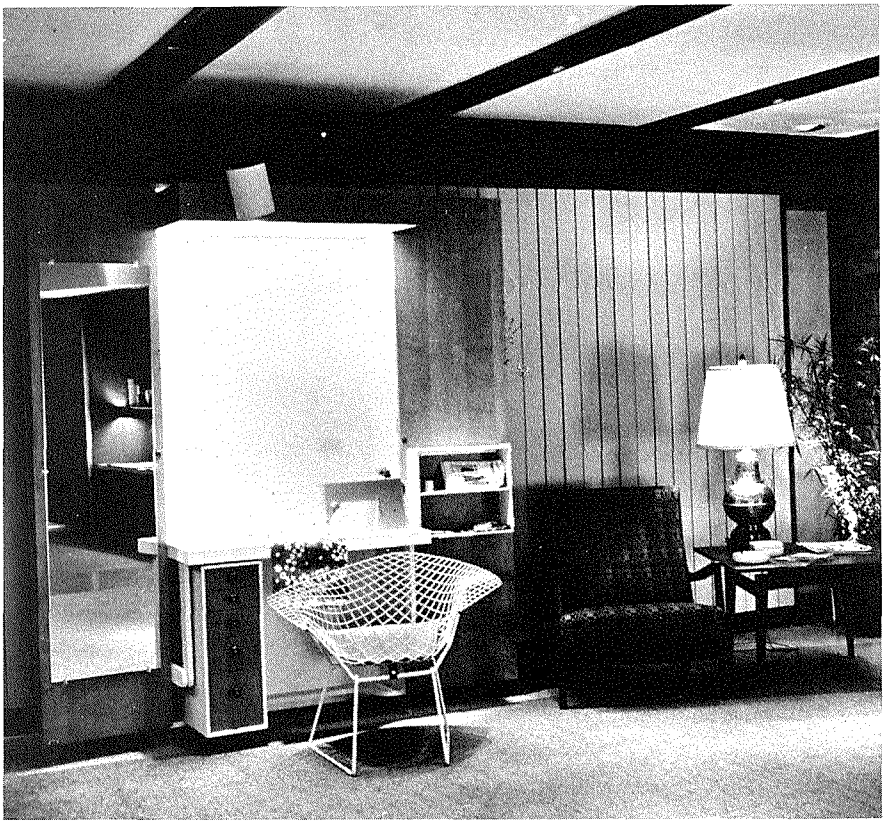
A modern hutch

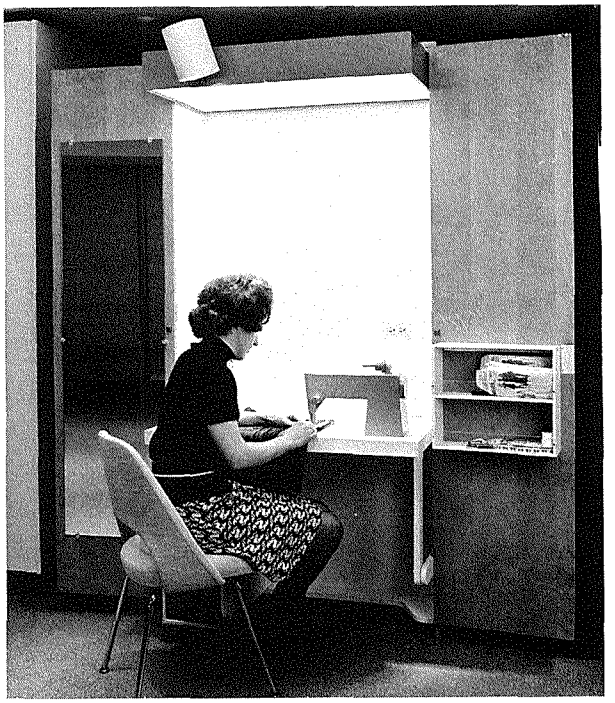
THE ROOM DIVIDER can be used as a breakfront by simply parking it along a wall. Because the shelves are of glass and the unit has three 50-watt reflector lamps, it can serve handsomely to highlight decorative objects or favored family collections. The storage space below is a bonus sure to be welcomed in most households. The beauty of the modular concept of construction is that the pieces all have the look of custom built-ins, yet should you ever move you can take the furniture with you. Wires from the lights exit through small holes in the top and are held fast to the back of the piece with insulated staples.

For a neat job, simply measure the exact length of the extension cord you will need and cut it to suit. Then attach the extension cord to the baseboard, running it along the wall using insulated staples.

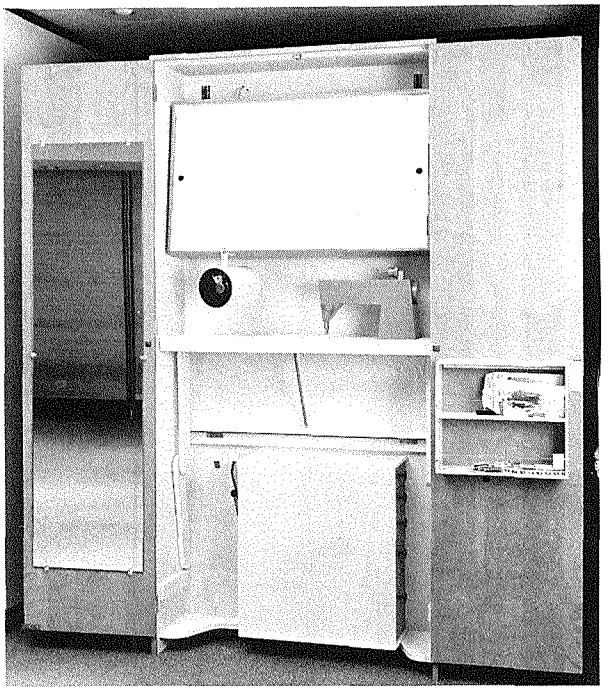


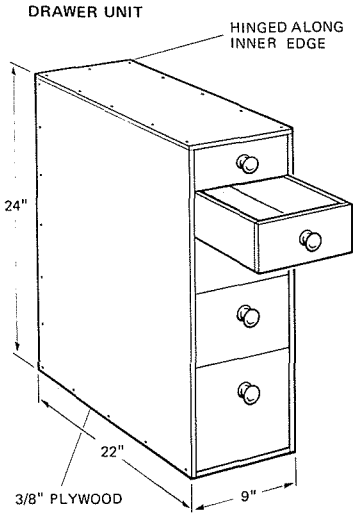






Compact sewing center



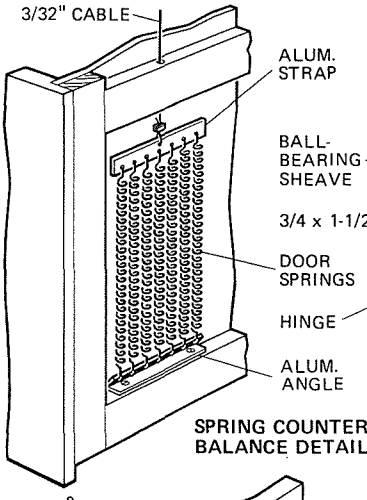


OPENED sewing center reveals a full-length mirror on the left door and a storage unit on the right. Four-drawer pedestal in the drawing at left is built using simple, basic construction techniques.

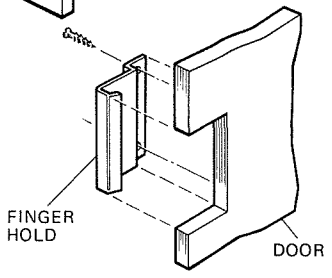
WHAT APPEARS to be a handsome wardrobe here actually becomes an efficient sewing center when opened for use. The design is intended to solve the problem for those who want such a facility and have no place to put it except in the bedroom.

When the doors are opened, a full-length mirror is revealed on the left door, and at right is storage for all the accessories a busy seamstress likes to keep close at hand. There is also additional storage available in the pull-out drawers.

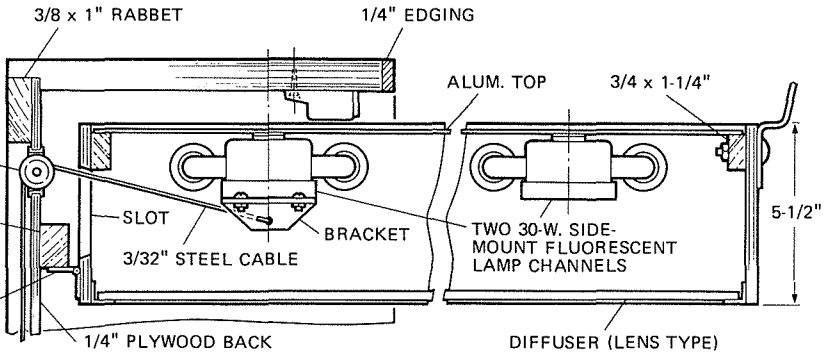
The sewing-machine counter pulls down to create a full 24-in. depth. The panel then swings up on a spring device, allowing for an extra-deep lighting fixture to fit into place. Four 30-watt Deluxe Warm-White fluorescent lamps provide general lighting, while the spotlamp—angled toward the machine's needle—provides the pinpoint light necessary to see thread against fabric without causing squinting and eyestrain.



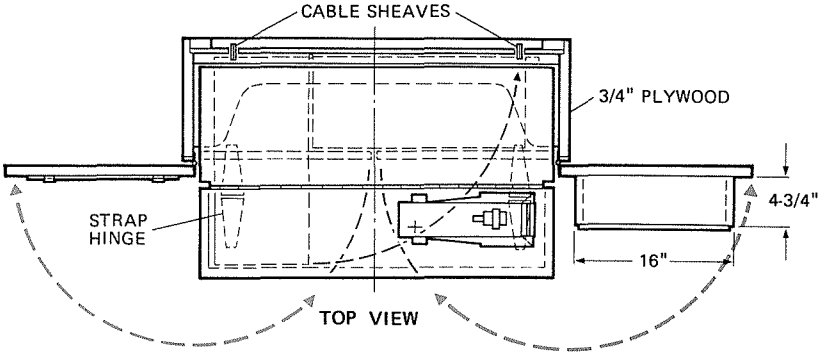
SPRING COUNTER-BALANCE DETAIL



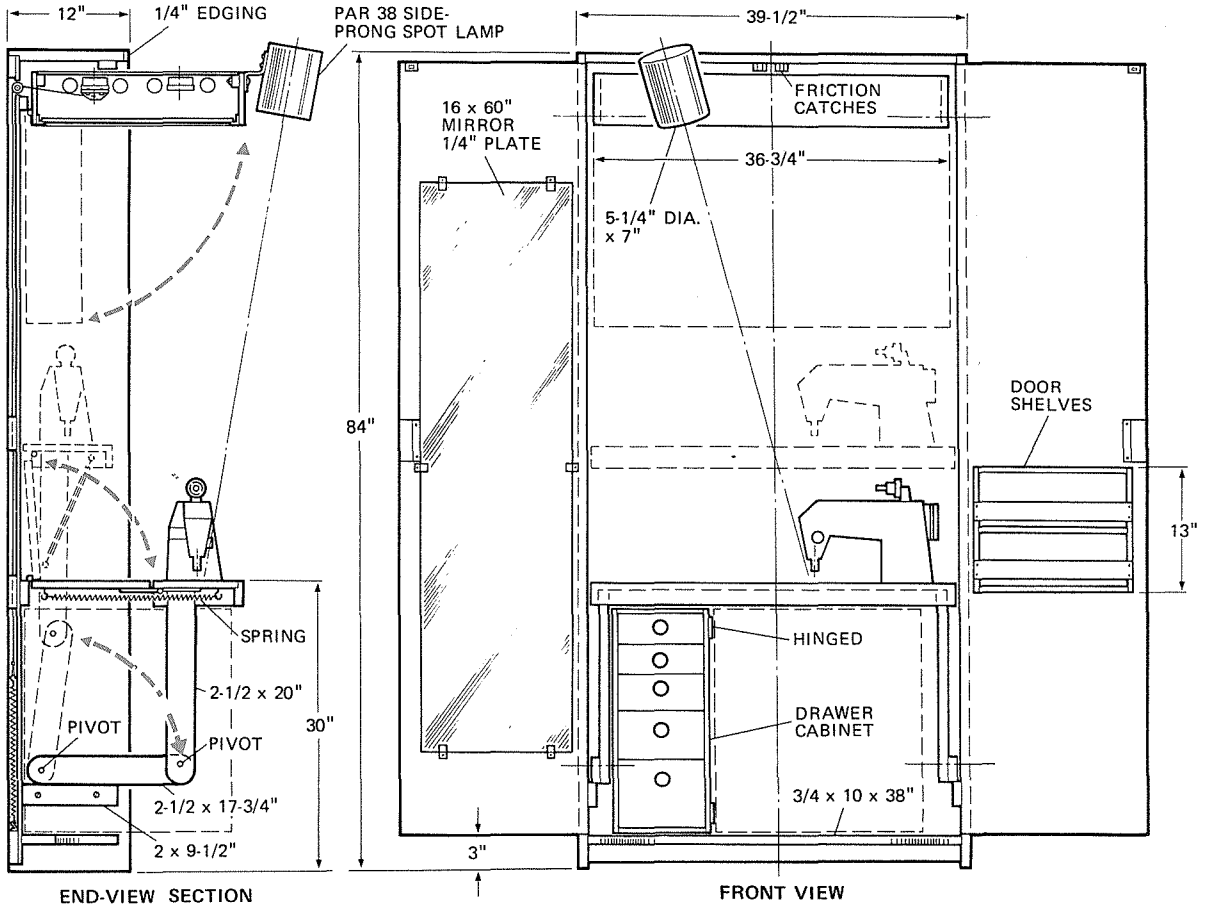
FLUSH DOOR HANDLE



LAMP-BOX DETAIL



TOP VIEW



END-VIEW SECTION

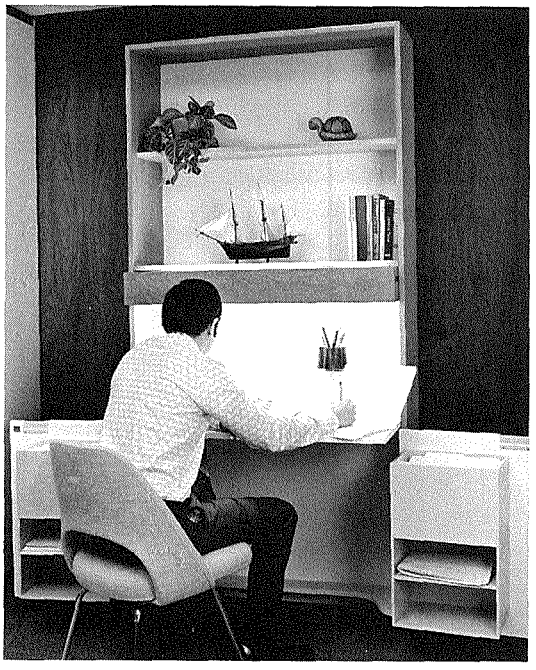
FRONT VIEW

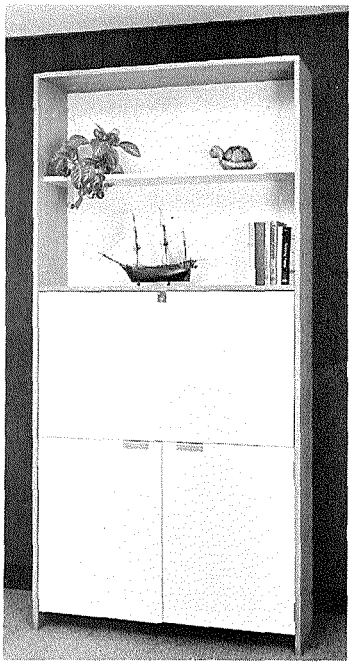
BY OPENING the lower cabinet doors to expose filing space and lowering the upper door, you get a 24-in. desktop. The lighting unit pulls out to light up the shelves and desk surface.

Versatile work or hobby bench

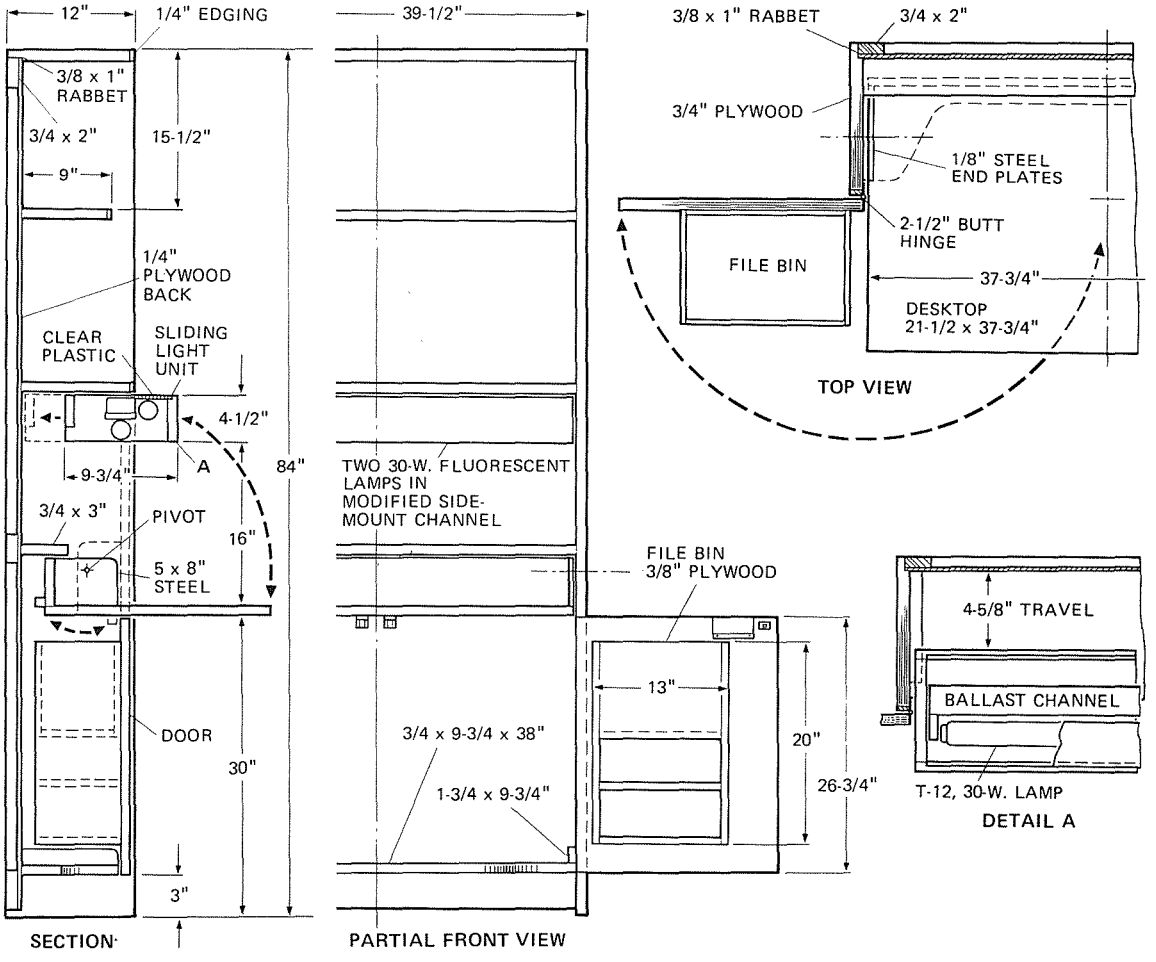
AT FIRST GLANCE (see right photo on facing page) the closed desk appears to be a shelf-storage area. However, when you open the lower pair of doors a counter flips down and becomes a 2-ft.-deep convenient desktop. The lighting element pulls out so light is distributed both down on the desk work area and up toward the shelves where reference books and knicknacks can be stored. Note the convenient file storage bins that appear on the sides of the lower doors.

For work surfaces such as the desktop (and the sewing center on page 2052), a plastic laminate should be used for durability, a smooth working surface, and to keep maintenance at a minimum.





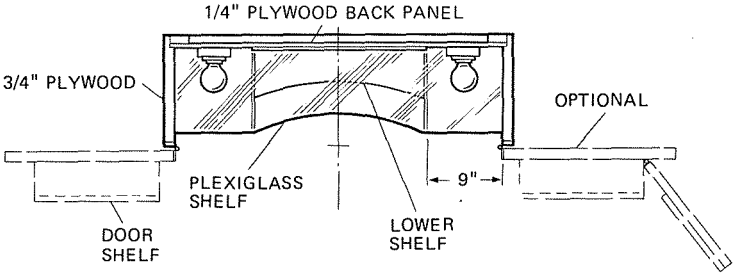
WOULD YOU believe it's a desk? When closed (right photo), unit seems to be something it's not — a breakfront. The simple structure provides necessary room for the family record-keeping.

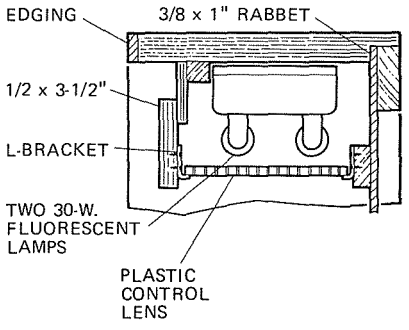


PERSONAL GROOMING center for the lady of the house is a scant 1 ft. deep and 39 in. wide. Height can be varied to suit the room's decor.

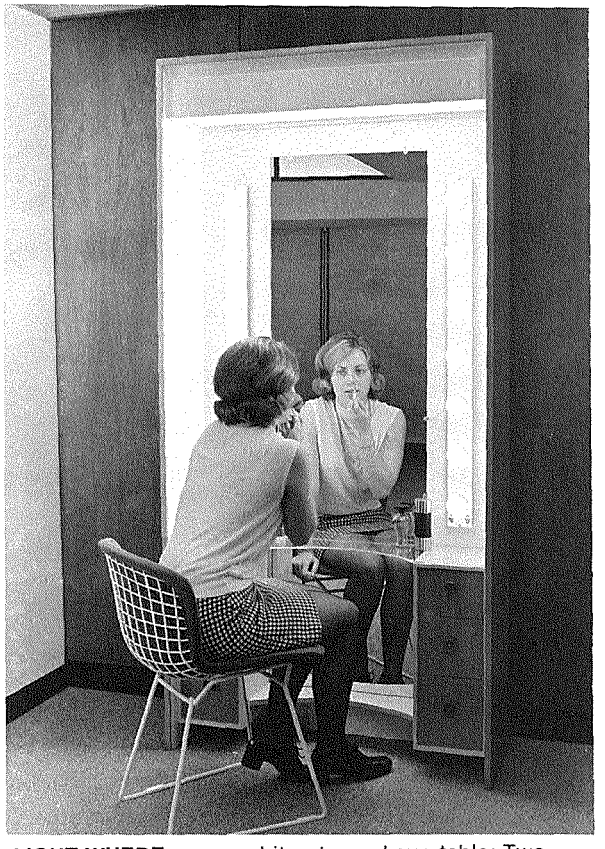
Build a vanity

THE VANITY CENTER is planned for personal grooming and can be used either sitting down or standing. Since the top surface (shelf) will not be exposed to rough treatment which might scratch or mar it, it is of ¼-in.-thick clear sheet acrylic plastic (such as Plexiglas or Lucite) so it is possible to utilize the full-length mirror. The lighting is a combination of decorative incandescent globe-shaped bulbs (14 25-watt No. G 18½ lamps) on both sides of the mirror and a pair of 30-watt deluxe fluorescents in the hood overhead.

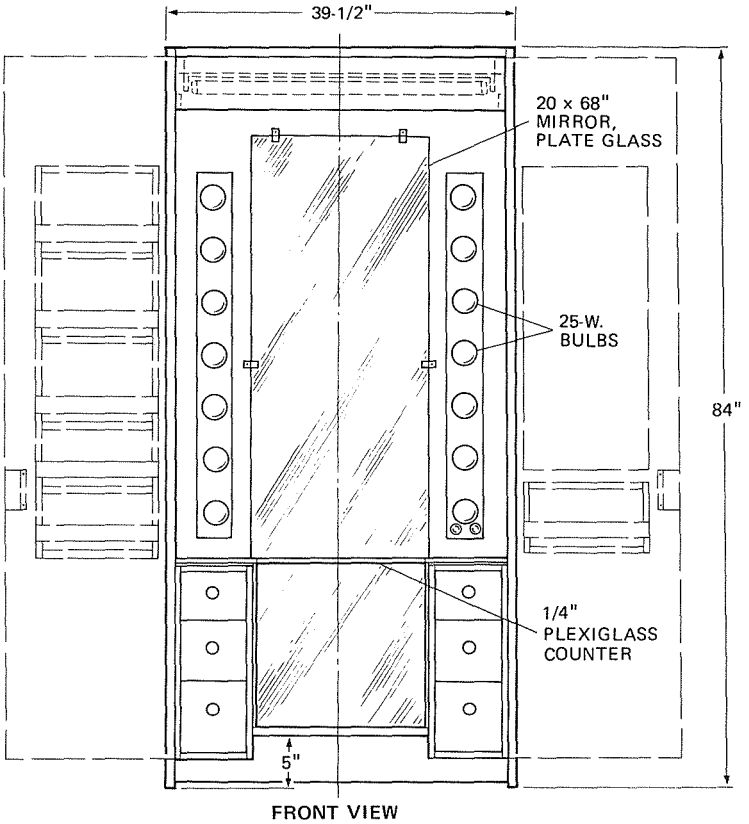




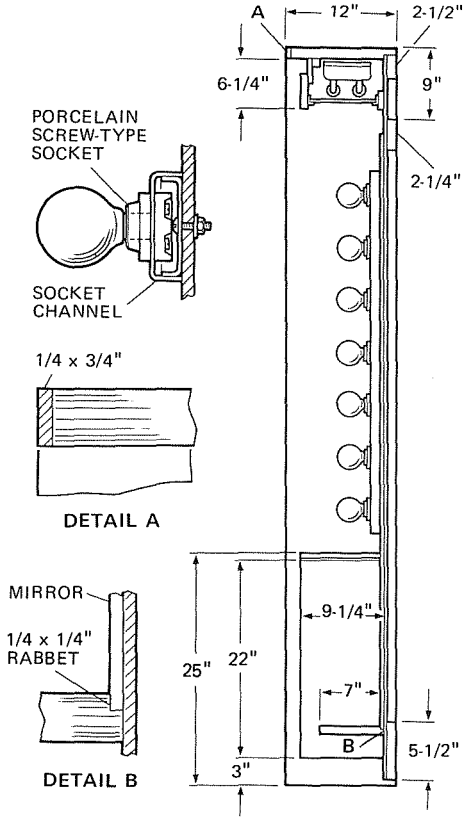
TOP VIEW



LIGHT WHERE you need it—at a makeup table: Two Deluxe Warm-White fluorescents overhead and 14 incandescent bulbs give all you could ask for.



FRONT VIEW

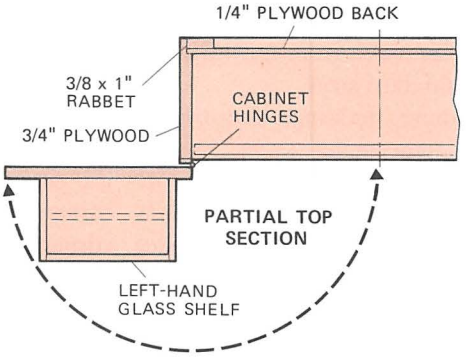


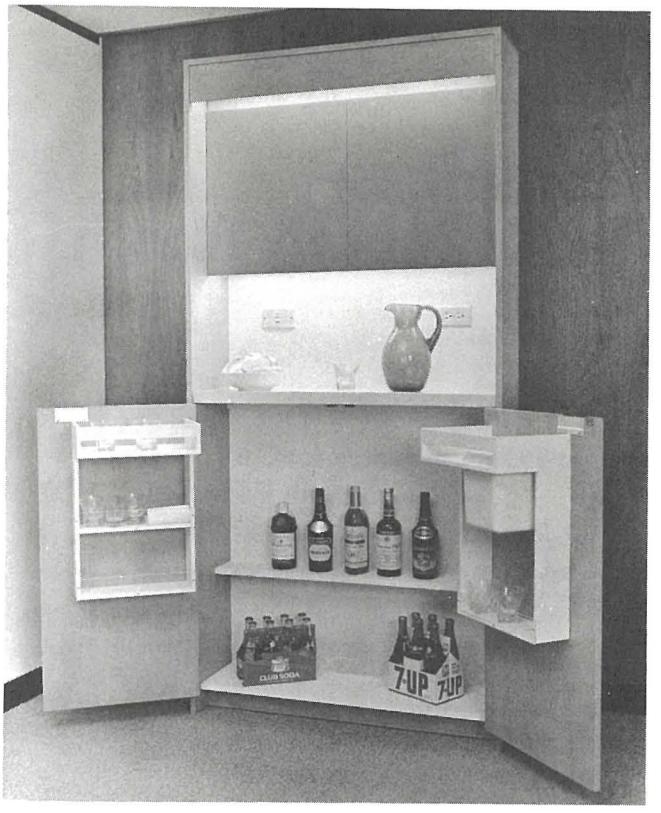
WHEN USED AS a bar-counter, the modular unit provides convenient storage under fluorescent lights.

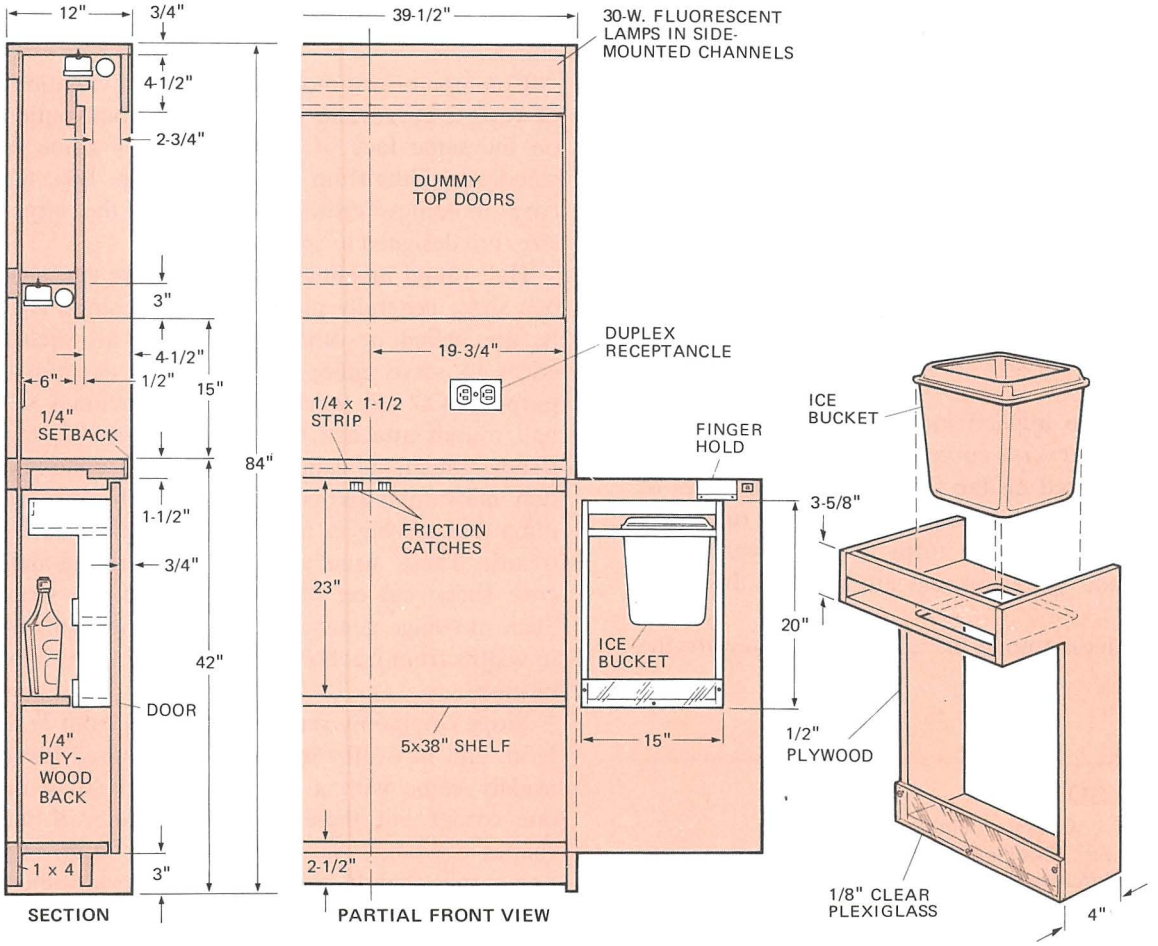
Service bar

THE SAME MODULE with slight variations becomes a handy service bar with ample room for storing potables and ice cubes.

Wall systems such as these units are popular in the furniture market now, and by starting with these concepts, recognizing that sizes and designs are not fixed, you can design your own wall system at a fraction of what the commercial equivalents cost. For example, consider combining several modular elements. Two wall dividers used with a desk unit and the bar above will give about 13 ft. of wall with plenty of space. Turn your imagination loose, rearrange the wall however you want and find the arrangement that's most convenient for your current activities. You may even want to consider an L-shaped island or peninsula.


1/4" PLYWOOD BACK
3/8 x 1" RABBET
CABINET HINGES
3/4" PLYWOOD
PARTIAL TOP SECTION
LEFT-HAND GLASS SHELF


7-UP
7-UP


12"
3/4"
4-1/2"
2-3/4"
3"
4-1/2"
6"
1/2"
15"
1/4" SETBACK
84"
1-1/2"
3/4"
42"
DOOR
1/4" PLY-WOOD BACK
1 x 4
3"
SECTION
39-1/2"
30-W. FLUORESCENT LAMPS IN SIDE-MOUNTED CHANNELS
DUMMY TOP DOORS
19-3/4"
DUPLEX RECEPTANCLE
1/4 x 1-1/2 STRIP
FINGER HOLD
FRICTION CATCHES
23"
ICE BUCKET
5x38" SHELF
15"
2-1/2"
PARTIAL FRONT VIEW
ICE BUCKET
3-5/8"
20"
1/2" PLYWOOD
1/8" CLEAR PLEXIGLASS
4"

Moldings— the finishing touch

By W. CLYDE LAMMEY

Any woodwork without moldings has a certain unfinished look. It leaves you with a sense of incompleteness. Here are the molding shapes most readily available

No matter where located, moldings are a basic of design, an element to be utilized in a wide range of applications. Without moldings almost any structure, anything with dimension, is little more than a box shape with stark overhangs and uninteresting square corners.

But a molding is a shape that catches the eye. It adds something both elemental and decorative, the finishing detail, leaves you with the feeling that the job is complete.

Traditional architecture utilizes a range of applied moldings both inside and outside the structure; inside as a finishing detail in a room, such as picture molding; a coved mold in the corner where wall meets ceiling; as a baseboard with quarter-round and as door and window trim with stops having one molded edge. Outside you see moldings in various forms under cornices, around sash frames and around and over door frames.

Common applied moldings are combinations of curves, reverse curves and plane surfaces generally worked on the face, corners and edges of both hard and softwood lumber. As a rule these shapes come in the form of strips varying in width and thickness and are sold by the lineal foot.

Common among the applied moldings are the simple cove and quarter-round shapes which are cut on small square or rectangular strips. The former shape is ordinarily used as trim under an overhanging member such as a mantel, shelf or similar application. The latter you'll see forming the trim where a baseboard meets flooring. Of course, there are variants in the application and shape of these forms which are commonly known as bed moldings.

Crown and cove moldings are similar in that both shapes are usually cut on one face of stock varying in width from 2 or 3 in. to 5 in. or more in the standard sizes.

As these moldings are usually intended to span a right-angle corner, as in a room where wall meets ceiling, the back corners are cut at a 45-deg. angle and the adjacent corners are trimmed at 90 deg. to the 45-deg. corners, the flats serving as "stops" for the curves cut on the face.

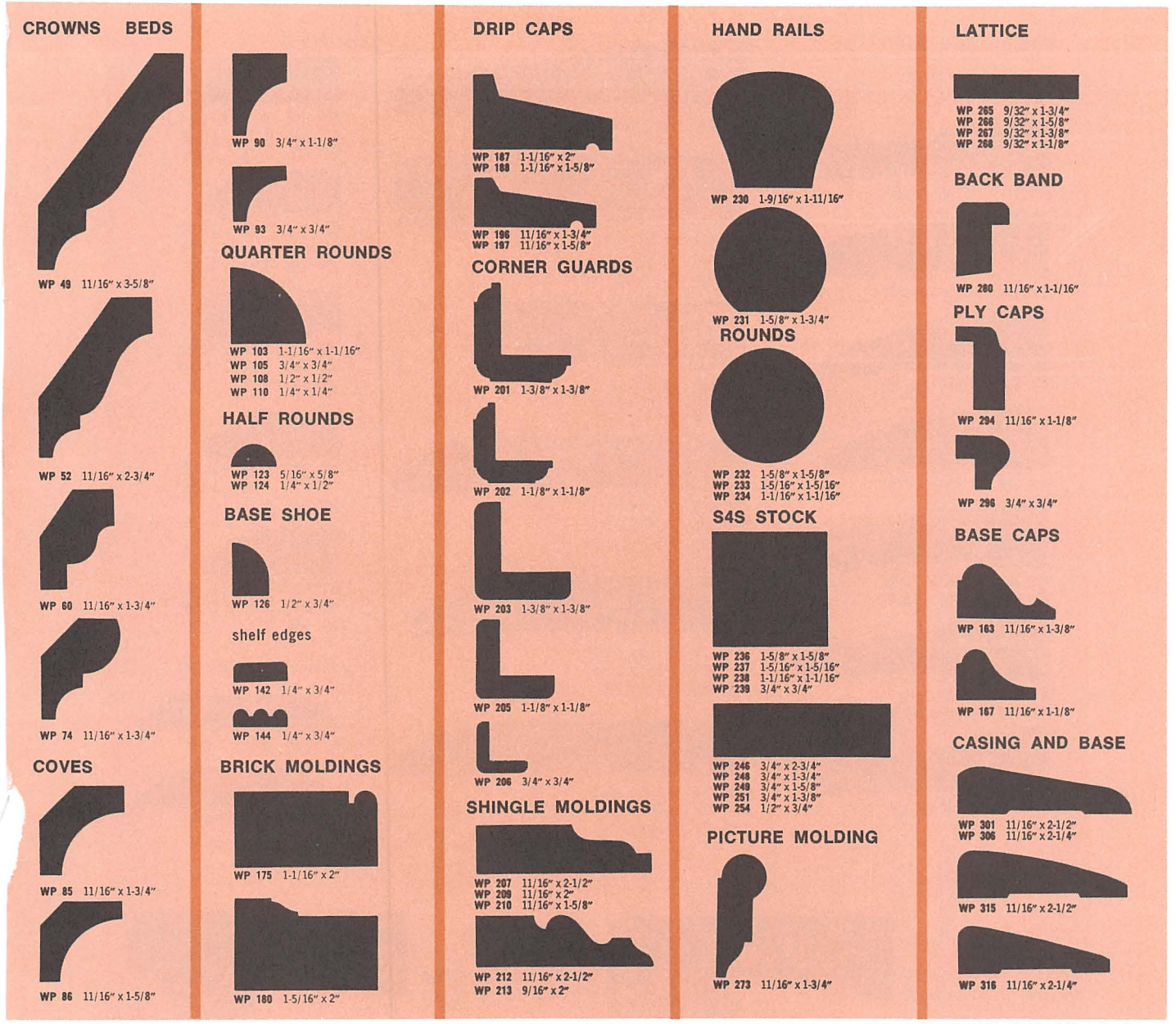
Cove moldings are commonly cut with a single concavity on the face, often the full width of the stock, but these also are cut in combinations of concavity and reverse curve, the former shape usually the wider of the two. A narrow plane surface, or flat, is usually cut between the shapes to serve as a stop at the ends of the curves.

Common crown moldings consist of variations of reverse-curve and cove cuts in combination on the same face of the stock. They come in standard widths from about 1½ in. up. Like the cove moldings, crown moldings in the larger sizes are designed to span a corner.

Half-round moldings, of which there are various sizes, generally are applied as nosings, that is, are nailed or otherwise fastened to square edges to serve either a practical or decorative purpose. On old work you will sometimes see half rounds attached to the outer edges of stair treads. Much the same is true of the combination half-round-and-cove mold which you will often find serving as a nosing on later-type stair treads. These usually have a half-round-and-cove shape cut on the same face of the strip. Such moldings generally come as strips ranging in widths from fractions of an inch to about 2 in. or more.

Stops commonly range in thickness from ⅜ to ½ in. and in widths up to 2 in. or more. These usually come with a reverse-curve molding on one corner but there also are variants of the shapes available. Some are supplied with only one corner slightly rounded to a uniform radius. Stops are used mainly in door and window

SEE ALSO
Ceilings . . . Doors . . . Finishes, wood . . . Frames, art . . . Joinery . . . Picture frames . . . Remodeling ideas . . . Sanding . . . Staining, wood . . . Windows



Western Wood Moulding Producers

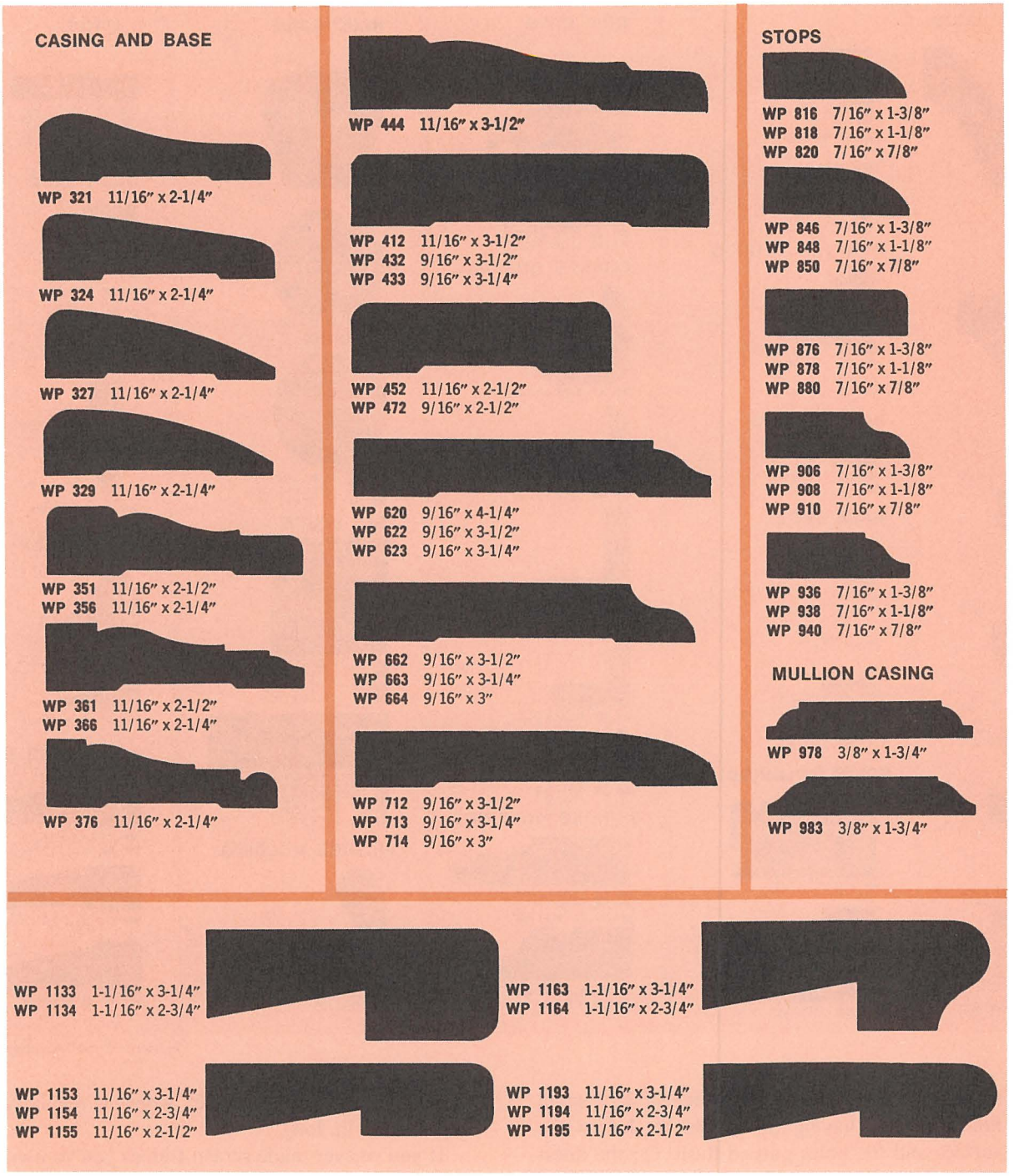
framing and are ordinarily attached with small finishing nails having the heads set below the surface and the holes puttied flush. On the finest work the stops are attached with ovalhead screws, the heads being countersunk flush or turned down on plated washers.

Other shapes which classify as moldings are full rounds, screen moldings, chair rails, window stools and corner beads to name a few of the many shapes. Some of these are not so commonly used in present-day construction but most are still available as replacements. Full rounds in larger sizes are often utilized as stair rails. A variant (although it does not classify as molding) is the well-known dowel, which is regularly supplied 36 in. long.

If you've ever made screen frames you've used one of the several forms of screen moldings and you'll see many of the other forms illustrated in nearly all old work and occasionally in newer structures.

All the illustrations, which are end views of the shapes, show only one size. But, of course, many of the moldings come in several widths and thicknesses to adapt them to various types of work.

When installing moldings around outside corners the ends are mitered and it's the usual prac-



tice to cut the two members just lightly over at the mitered ends. This assures a tight fit (if the miter is properly cut, of course) and should there be slight shrinkage of the wood, or movement of the framing due to shrinkage, the mitered joint will remain a tight fit.

Moldings that meet in an inside corner should always be coped, that is, one member is cut and nailed in place the full length, the end in the corner being cut square off. Then the end of the meeting mold is cut to a shape that will fit tightly against the first member, using a scroll, or coping saw, and making the cut at a very slight angle. Moldings that fit between walls should not be forced; rather they should be cut slightly under.

Screening basement sashes

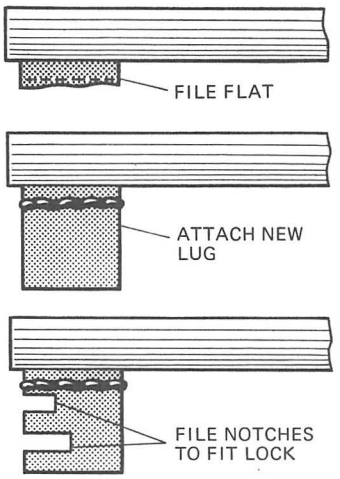
I have steel basement sashes which tilt inward to open and tilt upward to be removed. I'd like to install screens on at least two of the sashes but I haven't yet figured out a way of attaching the screen frames to the sash frames. I can make screen frames of wood, but can you suggest a way to attach the two?—N.F., N.Y.

Usually steel sash frames provide some means by which you can attach screens. Have you examined the frames closely for any small holes through which screws may be inserted from the inside? Or possibly there's some other means of attaching you may have overlooked. If not, it should be possible to drill holes through the frames, one centered on each side, in such a position that the screw heads will not interfere with full closing of the tilting sash. If the basement walls are of the poured type, the chances are you won't have much latitude in fitting the screen frames. Only careful measurements will assure the close fit necessary.

Desk key repair

I have an old desk with locks on all the drawers, and the wing or lug on the only key I have is broken off and has been lost. Can I repair the key or must I make do without?—J. Satterwhite, Lexington, Ky.

I once made such a repair, beginning by removing the lock and prying off one of the plates, which was held in place by bent-over metal ears or tabs. On some old desk locks the plates are held by a rivet and you may have to file the rivet head down to remove the plate. Once the plate is off, you have a clear view of the mechanism and from this you can determine the fit of the replacement lug.



Cut a new lug from brass and solder or braze it in place. Then place the key on the guide and mark the locations of the necessary notches, usually on the front edge of the lug. Only repeated trial and filing will determine the required widths and depths of the notches to operate the lock freely.

Sealing up storms

I have old wooden-frame storm sashes. In the past, you've mentioned that these should be sealed before winter arrives to prevent leakage of cold air into the space between the outer and inner sashes later. But how?—H.H., S. Dak.

There are several suitable weatherstrippings which are quite easy to obtain. Some are self-adhesive, or pressure-sensitive, and can be attached to the inner face of the sash frame along the edge at the top, sides and bottom. On some window framing it is necessary to attach the stripping to the bottom edge of the sash. There is also a felt stripping about ⅛-in. thick and ½ to ¾-in. wide that is attached with small tacks or a stapler. Tacks or staples should be spaced uniformly about 4 to 6 in. apart and the felt strips should be "mitered" at the corners.

After being stripped the sashes must be held in place with turnbuttons rather than hangers. Large sashes usually require three turnbuttons on each side and, if the sashes are exceptionally wide, one more turn-button at the top.

Recoloring streaked wood

I'm refinishing a table of cherry wood. A narrow, yellowish streak has turned up in the top. I've tried coloring it to match the reddish-colored wood with stains, but without satisfaction. Can you suggest a stain that will color the light wood to match?—Robert Woodson, Marietta, Ohio.

For coloring sapwood to match a darker heartwood, I've found artist's colors (oils) invariably produce excellent results. Often two or more colors must be combined to get the right shade, with colors applied direct from the tube with a fingertip and a darker or lighter color added as you go. A drop or two of turpentine makes the colors spread and blend more uniformly. It's a rub-in-and-rub-off procedure until the light and dark areas of wood match. Allow the applied color to dry for at least a week before you apply any final finishing material.

by W. Clyde Lammey

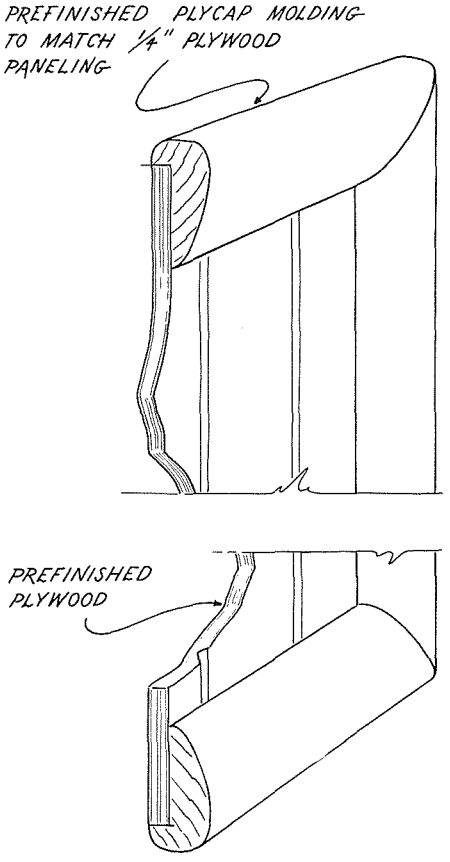
How to work magic with moldings

Inexpensive and readily available at your local lumberyard, standard moldings let you work wonders with your walls. Here are ideas and instructions

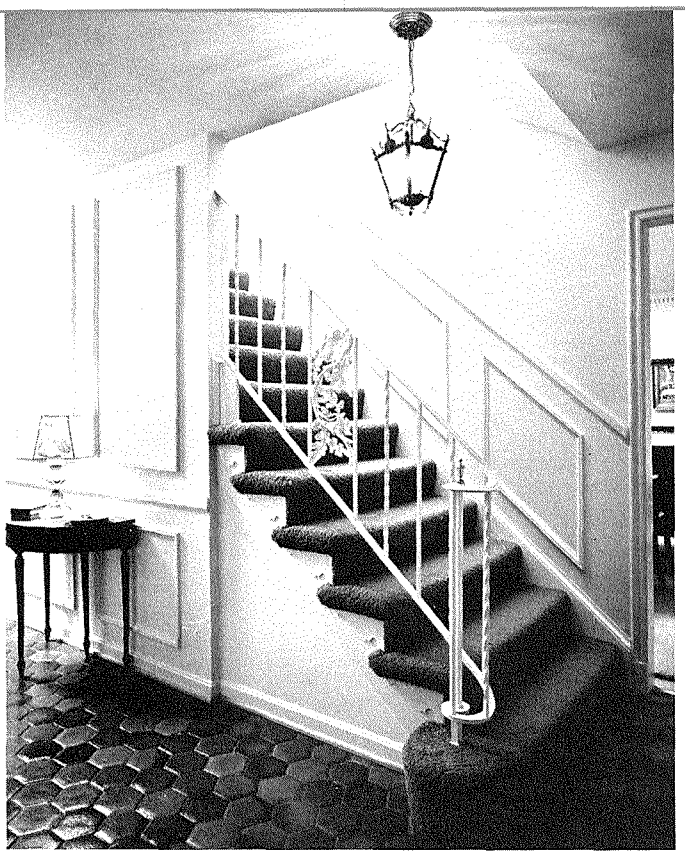
By HARRY WICKS

SEE ALSO
Basement remodeling . . . Doors . . . Entryways . . . Frames, art . . . Joinery . . . Nails . . . Remodeling . . . Remodeling ideas . . . Wall decorations . . . Wallpaper

■ THE NEXT TIME you plan to redecorate a room, pause a bit before deciding that a coat of paint or wallpaper is all you need to get a fresh look. With some planning, you will be pleasantly surprised at how dramatic a change can be achieved by simply adding wood moldings to the walls. Placing moldings on a flat wall surface is

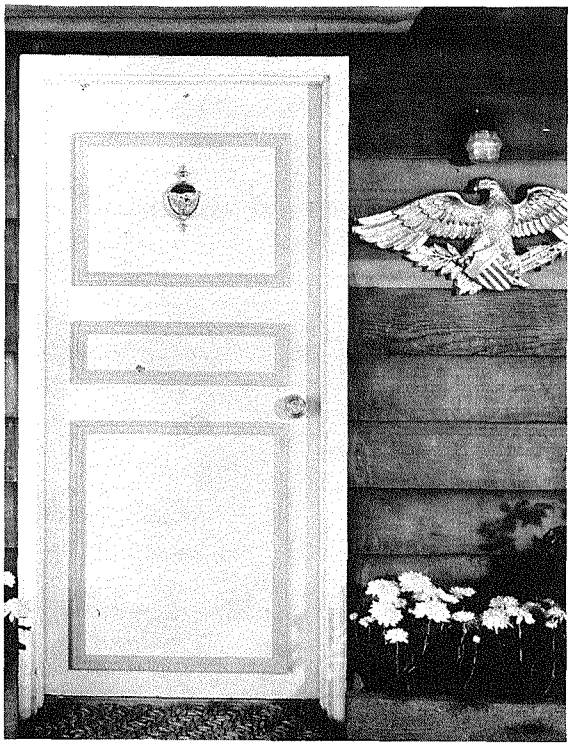


FRAMED plywood panels have a look of luxury, yet cost less than a fully paneled wall. The plywood is glued to the wall, then surrounded with lengths of prefinished moldings.

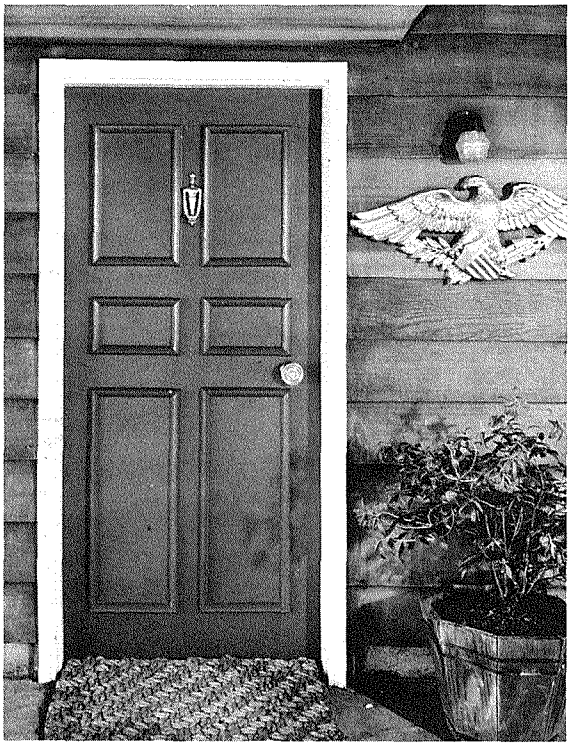


PANELED WAINSCOTING helps to reduce the feeling of height and emptiness along a stair wall. Section drawings of the moldings used in room on this page are shown on the following pages. Detailed know-how for working with moldings begins on page 2068.

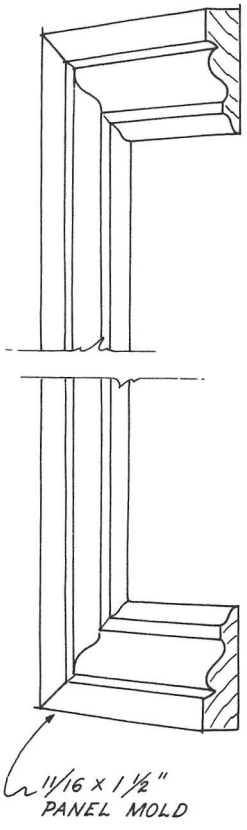
WALLPAPER OR FABRIC can be used in conjunction with moldings to create a new room mood. Here, wallpaper is pasted on inexpensive C-D plywood that is then trimmed with selected moldings. Each framed panel is then suspended against the wall from two hooks.



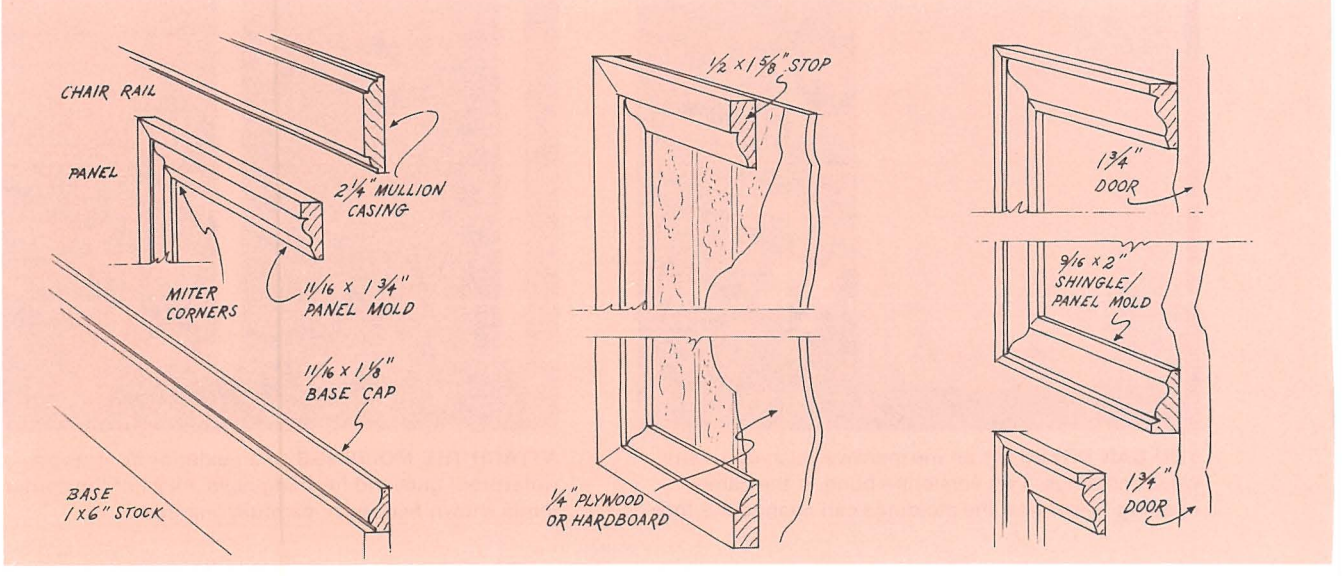
YOU CAN DRESS UP an inexpensive flush door with wood moldings. Two versions—hung in the same opening show how the moldings can change the look.

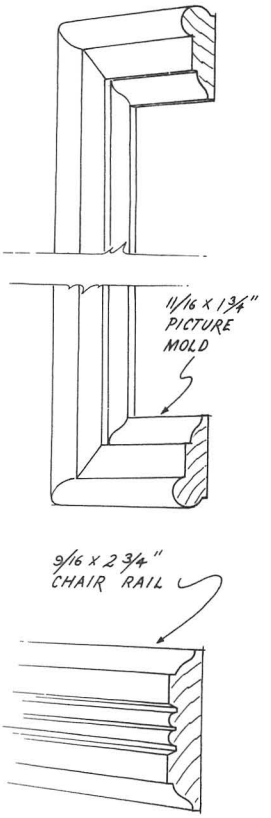


ATTACH THE MOLDINGS to an exterior door using waterproof glue and finishing nails. All 24 of the corner joints shown here were carefully mitered.

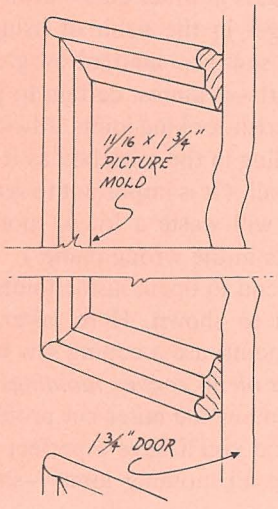


MOLDING DETAILS can be effectively used to set the period of design. To duplicate the room shown above, panels must be sized proportionately to suit the size of the wall.





FRESH, CRISP LOOK is achieved by painting moldings to contrast with the walls. The chair rail not only looks good, but acts to protect the walls from chair bumps.

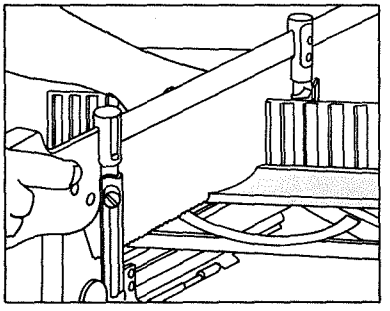


an inexpensive way to create a luxurious look.

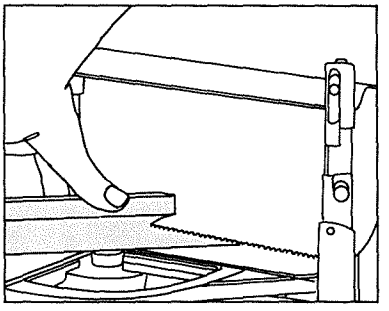
Wood moldings are available in a large variety of styles and sizes at most lumberyards. The rooms shown are good examples of what you can accomplish through thoughtful use of moldings. And when you have the know-how for working with this shaped stock, you'll be able to duplicate these examples more easily than you might suspect. The key to successful use of molding lies in careful planning.

Your first step should be a trip to your local lumberyard to learn which moldings it keeps in stock. Armed with this information, take the time to draw a scale floor plan and wall elevations of the room. To lay out a room such as the one above, the elevation drawing should indicate the

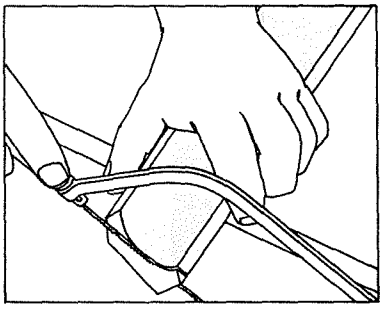
How to miter and cope moldings



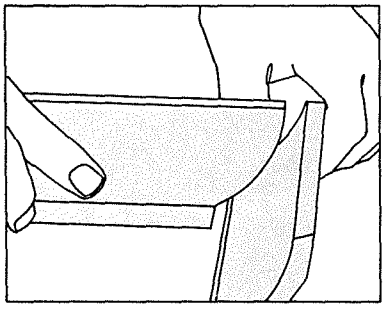
SET MITER box saw at 45° for miter cuts. Always hold molding securely while doing the cutting.



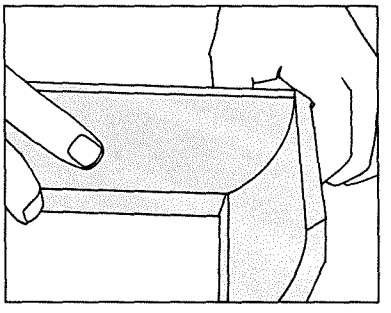
TO COPE a joint, first make the miter cut to the exact length desired as shown in diagram.



NEXT, with coping saw held at 45° angle, follow miter line (profile) to cut out wedge-shaped piece.



TEST-FIT the coped molding against piece of molding it will abut. In sequence shown, it's cove mold.



YOU CAN use a block plane and sandpaper to ensure a tight-fitting joint. Glue and nail to fasten.

chair rail at desired height (36 to 42 in.). Work out panel design and sizes so the wall will be symmetrical with panels balanced in height and width, and the spaces between panels equal.

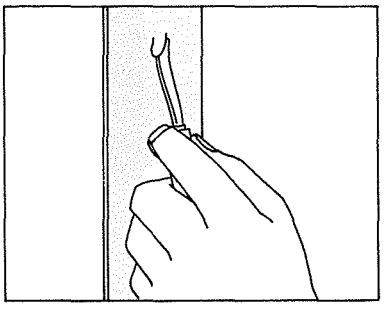
The examples shown in photos and section drawings on these pages can be duplicated or can serve as a springboard for your own creative designs. For more information, write to Western Wood Moulding and Millwork Producers, Dept. PM, Box 25278, Portland, Ore. 97225. Or check out the free literature rack at your local lumberyard.

molding know-how

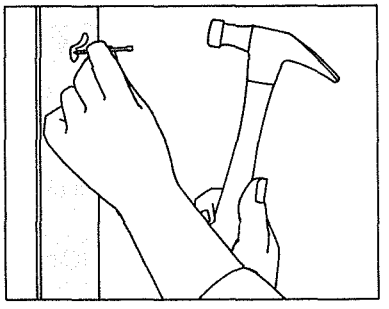
Make no mistake about it, your molding job will look only as good as the craftsmanship you put into it. How joints fit and nails are placed reveal just how much effort was applied. The first rule is never to guess at miter cuts—always use a miterbox. Also, get in the habit of using sharp saws only. A dull saw—no matter how great your patience and effort—is almost certain to produce unsightly, amateurish-looking joints. Always place the piece of molding in the miterbox as it is to be installed on the wall. (It is important to remember this rule or you will waste a lot of molding by making miter cuts in the wrong plane.)

Because they tend to open, inside joints should always be coped as shown. Here, after cutting miter at desired point, use a coping saw held at a 45° angle, *a must on all convex moldings,* to create a back-cut. Follow the miter-cut profile to cut out this wedge and you'll have a perfect joint. A coped joint—like all molding joints—should be installed with glue as well as nails.

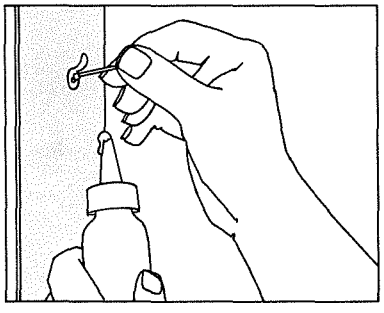
How to do blind nailing



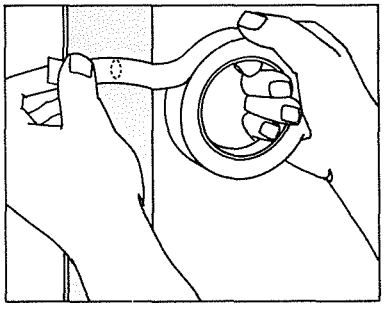
CAREFULLY gouge up a small sliver of wood that's wide enough to conceal the finishing-nail head.



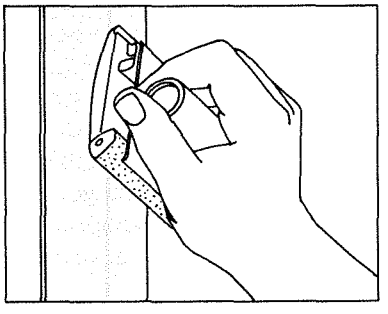
SWING the sliver carefully out of the way and drive the nail. Then set the nailhead well.



APPLY white glue to the sliver and push it into place. Immediately wipe off any glue ooze-out.

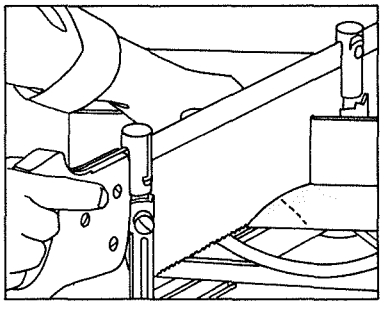


PRESS on a piece of masking tape to hold the sliver in place until the glue is completely dry.

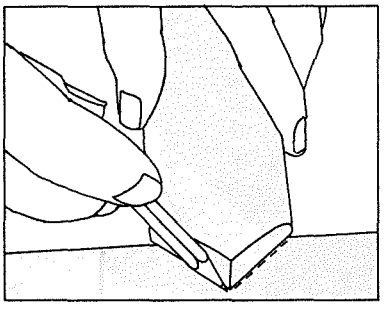


AFTER glue dries, remove masking tape and touch up the blind spot with a fine-grit sandpaper.

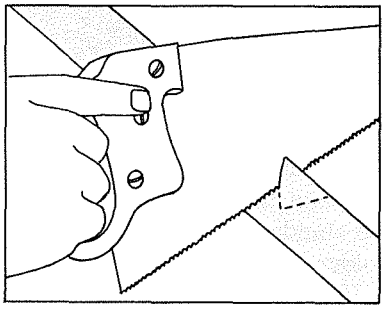
Where moldings meet at right angles



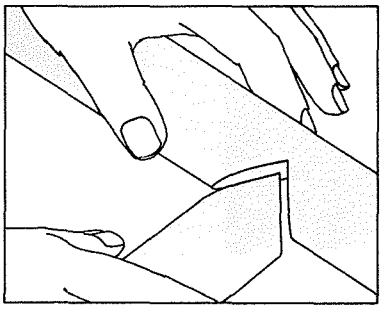
TWO 45° CUTS are made to create point with length equal to exactly half-width of the molding.



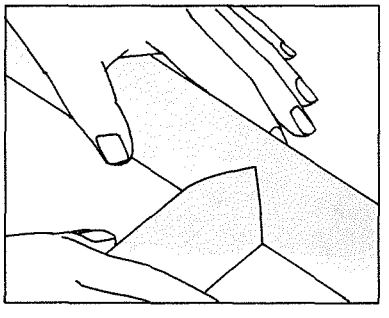
USE THIS piece as the layout pattern for cuts to be made on the piece it will join.



FOLLOWING the lines, use a fine tooth, crosscut saw to make the cutout on the mating molding.



CHECK joint for fit. If you made the cuts carefully, joint should be practically invisible.



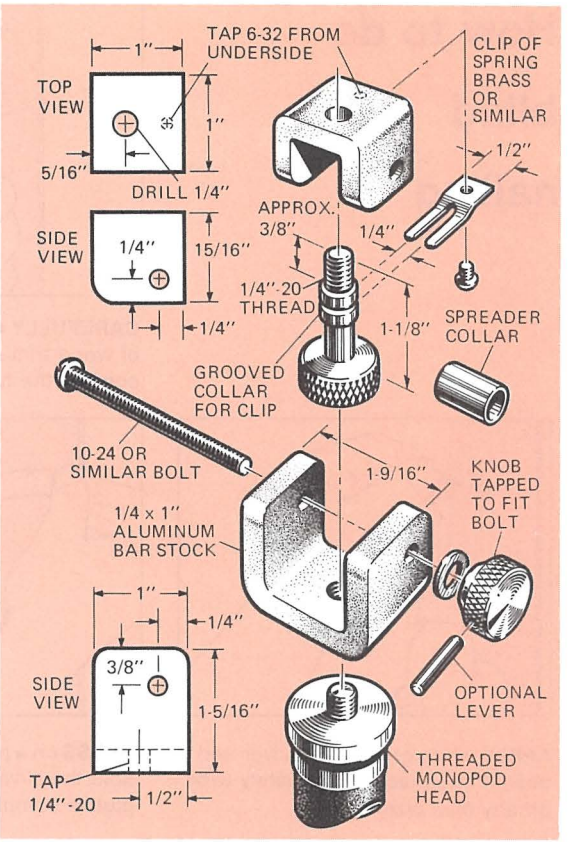
WHEN satisfied with the joint, use glue and toenail several brads through one mold into other.

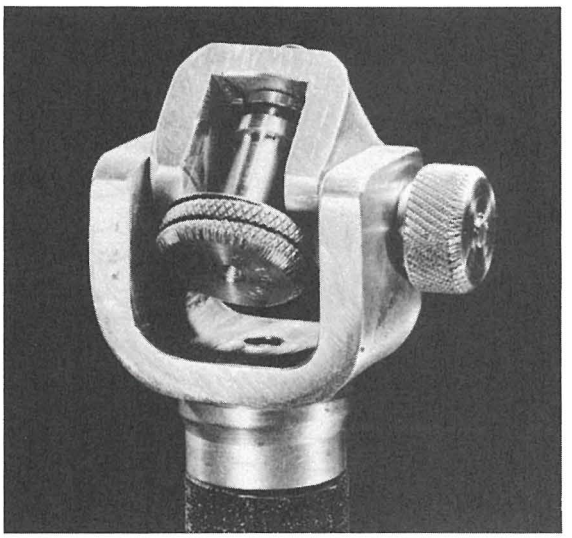
Tilt-top for monopod shooting

By WALTER E. BURTON and IRL GORDON

■ ONE-LEGGED MONOPODS may not be as steady as tripods, but they're a lot more portable—and still a lot steadier than nothing. The lack of a tilt head is no problem when you shoot objects near eye level, or distant scenes—just lean the camera and unipod together for whatever slight tilts you may need. But when shooting up or down at steeper angles, you have to tilt the unipod so far that it can't support the camera. Here, a tilt-head is needed—but tilt-heads made for tripods are so bulky that they eliminate the unipod's main advantage: compactness. Ball-and-socket heads, though compact, tend to tilt in too many directions at once.

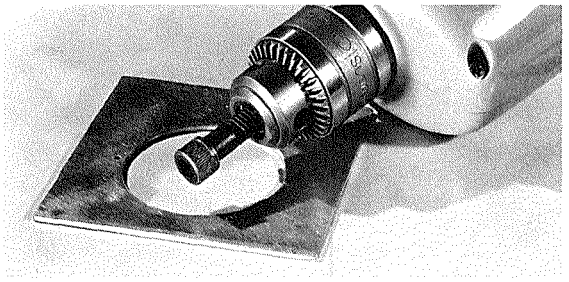
Hence this ultracompact tilt-head, designed specifically for monopod use. It's basically a hinge made of two pieces of aluminum bent into U-shapes (we used a hammer and bench vise), then drilled. We also filed flat the surfaces that bear against camera and monopod. The camera-holding screw and the hole tapped in the bottom piece are standard ¼-20 thread. If you have no lathe, solder or weld a washer to a regular tripod screw. If it's hard to loosen, a coin slot cut in the screw-head will help. You can use a wingnut on the horizontal clamping screw, but we find a knurled nut with $^{3}/_{16}$-inch brass lever rod, cut to protrude ⅝ inch, neater.



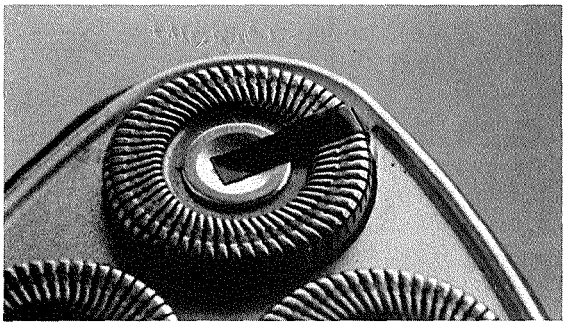


SEE ALSO

Camera bags . . . Lenses, photo . . . Photo hints . . . Photography . . . Used cameras

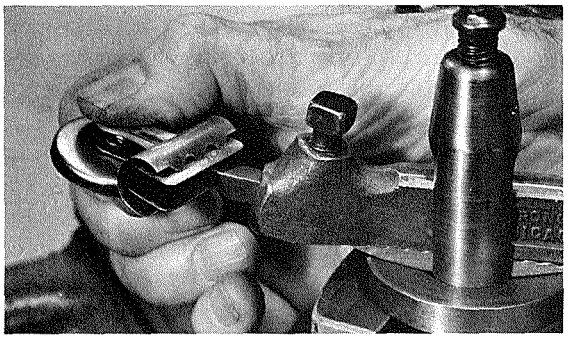


A KNURLED SOCKET-HEAD capscrew chucked in a drill press or portable drill can be used to deburr and knock sharp edges from soft metal and nonmetal items. Here, one is enlarging a hole in sheet aluminum.—*W. B. May, Oak Park, IL.*

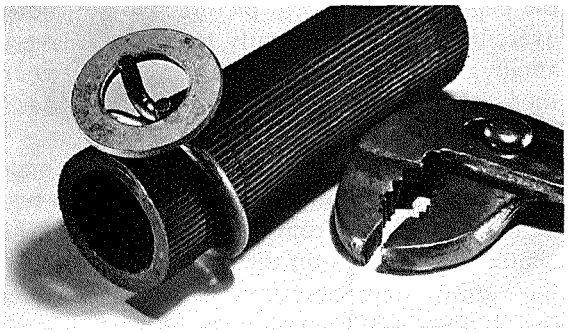


A BROKEN SECTION of a cutter head on a rotary electric razor can cause painful scratches and cuts on your face. You can solve the problem by applying a small piece of vinyl electrician's tape to cover the damaged portion of the head. The tape will not impair cutter action, yet offers positive protection from the rough metal.—*Fred Sanford, Reston, VA.*

WHEN I BROKE THE HANDLE on one of my handsaws recently, I wasn't exactly excited about replacing it with one of the newer, less comfortable types. So, I applied contact cement and yellow plastic laminate to both sides of the split handle. After trimming all the edges, the handle is as comfortable as ever and the saw is easy to spot on the job.—*Joseph Zebrowski, Port Charlotte, FL.*



AN UNPROTECTED TOOL BIT can give a lathe operator a nip if it's left exposed while he changes a chuck or makes some other adjustment. A simple protective measure I use is to snap on a magnetic clamp—like the one shown at left—over its tip. Any clamp can be used but the magnetized kind simplifies parking the clamp on lathe when it's not needed.—*B. W. Ervin, Kent, OH.*



PUTTING RING CLAMPS on radiator hoses can be an easier process with this hint. Simply put the clamp partly in a vise and squeeze the ends together with a thin pliers. Then slip on an appropriate-size washer over the ends to hold them. After inserting the hose, just remove the washer.—*Harold A. Miller, Ridley Park, PA.*

Mounting a whole collection of prints on a background panel is a handsome way to display photos that usually get stored away in the bottom of a bureau drawer

OUTDOOR PHOTOGRAPHER E.P. Haddon is shown here displaying some of his many montages of animals. Note the arrangement around a dominant photo.

Make a photo montage

By E. P. HADDON

SMALL PICTURES often don't look like much by themselves so there's a tendency to file them away. But put a whole collection of pictures together and you suddenly have an interesting, story-telling display that can make an attractive wall decoration. Montages are an ideal way of capturing events that require a variety of photos instead of just one big picture—scenes from a vacation trip, animals at the zoo, the humerous antics of a baby learning to walk.

Making a montage requires just enough artistic skill to be fun and a challenge. You can arrange your pictures in many ways. Sometimes a montage is built around one central, dominant photo. Sometimes the repetition of a single subject shown in different poses or wearing different facial expressions can be effective. Generally, the most interesting arrangements are a combination of both vertical and horizontal views. Group your subjects so they're looking in toward the center rather than off the edges.

A montage can be any size, but 16x20 inches is a good choice. This is a standard mounting-board size, readily available at photo and artists' shops. Use a white pebble board and leave a border of 1 to 1½ inches around the edges.

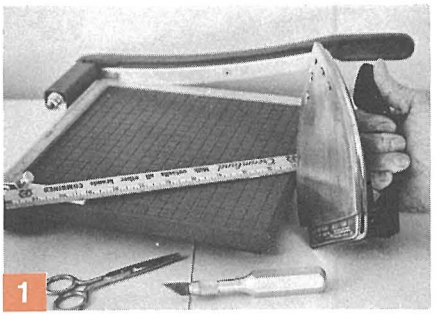
The prints are held to the board with dry-mounting tissue, also available at photo and artists' shops. This is an adhesive sheet that's slipped between the print and the board and then melted with an electric clothes iron to bond the two firmly together. First, tack the tissue temporarily to the back of each print with the tip of the iron. This way, print and tissue are trimmed together to the final shape. You then cover the prints with a protective sheet of typing paper and iron over the top to bond the pictures to the mounting board. Never use rubber cement to mount photos as it will bleed through and discolor the surface.

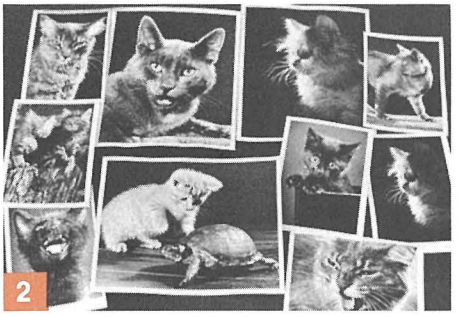
In fitting your pictures together, make the lines between them deliberately irregular to create a natural, random look. To get neat seams between prints, cut the edge on one first, then use this as a template and trace its outline onto the edge of the adjacent picture. Do not, however, butt the edges tightly together. Leave a small gap—about ⅛th of an inch—between them. This outlines the prints in white and adds a dramatic effect.

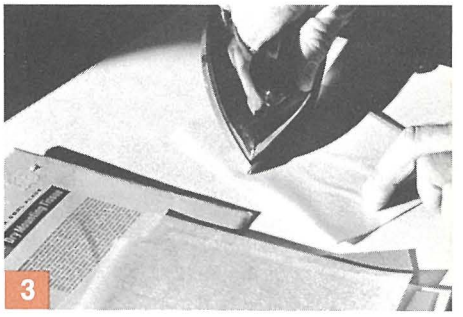
Don't attempt to mount all of the prints at once or they may shift out of place. Mount one or two at a time, working from the borders toward the center. The photos on the opposite page show the various steps necessary in putting together the montage and mounting the photos.

SEE ALSO

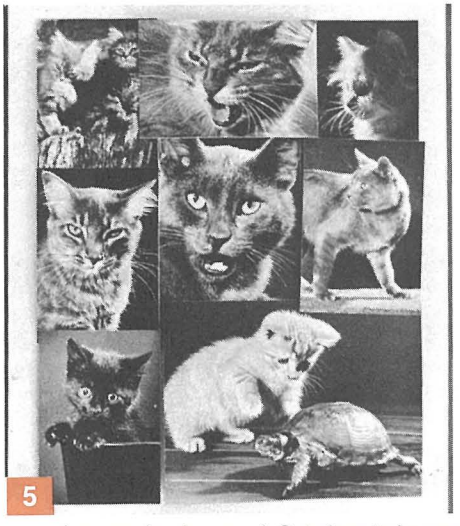
Bird photos . . . Close-up photos . . . Frames, art . . . Mountings, photo . . . Outdoor photography . . . Panorama photos . . . Photography . . . Picture frames . . . Prints, photo





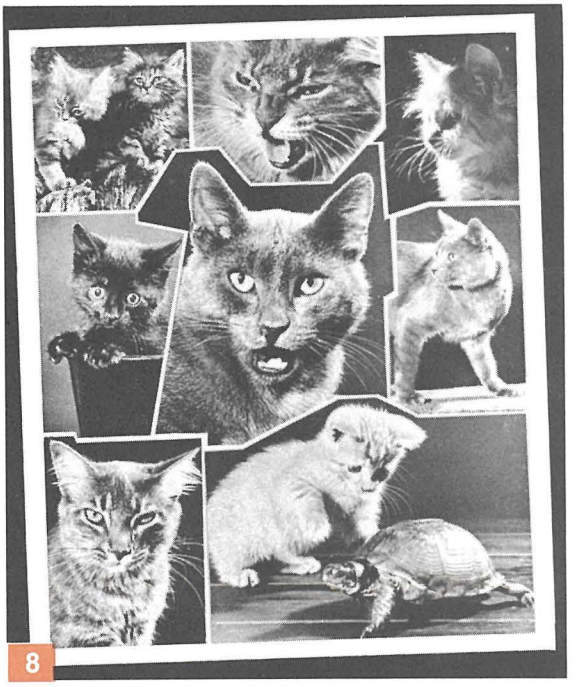


1. ONLY TOOLS needed are scissors, a ruler and an electric iron. Paper cutter speeds trimming, and a sharp mat knife is useful for intricate shapes. 2. Lay out your pictures to get an idea of how many you'll need and which looks best. Mix verticals and horizontals. 3. Tack dry-mounting tissue to back of each print with tip of iron. Cover tissue and run medium iron down the center for about an inch.

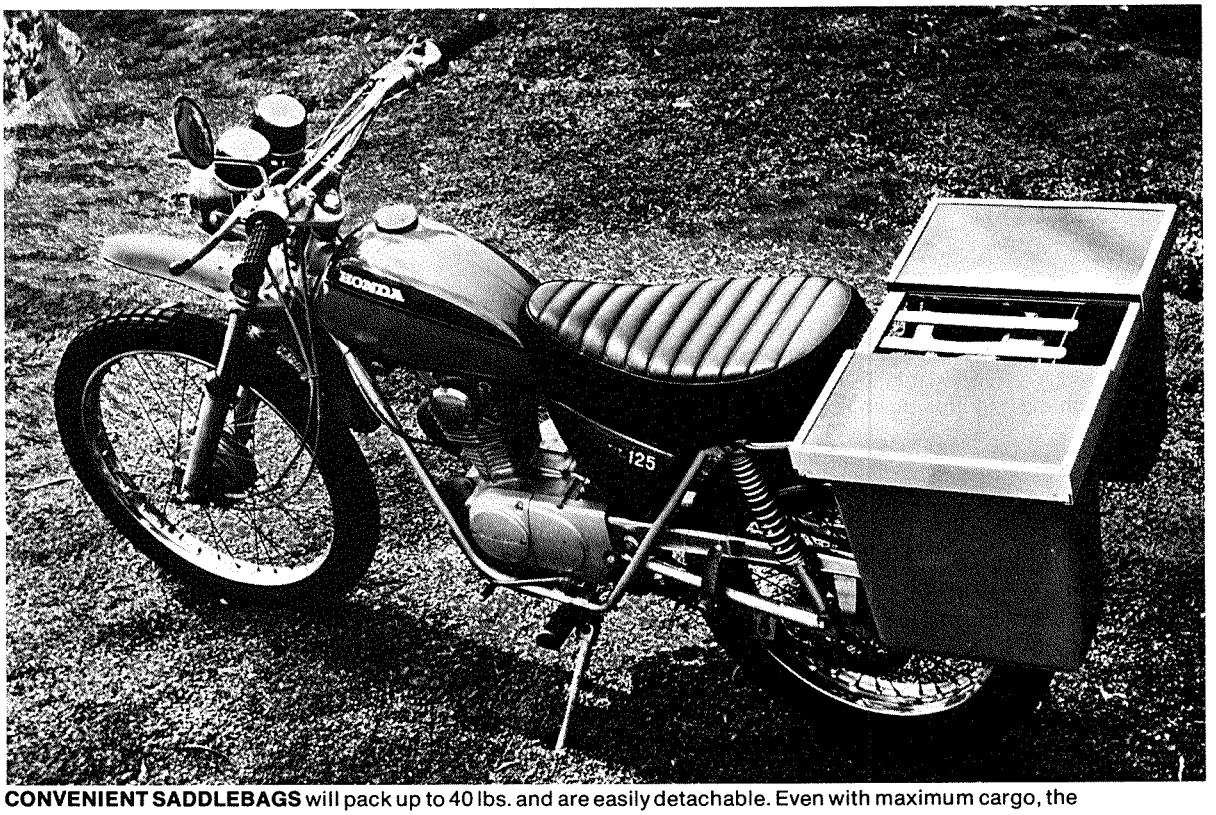


4. ROUGH-TRIM each print to remove the borders and excess background. Cut close to image without slicing into it. Cut right through dry-mounting tissue. 5. Make trial arrangement of rough-trimmed prints to find the most pleasing order. Group should have one or two dominant pictures. 6. Overlapping edges are trimmed off to create interesting patterns. Trace cut edge of one picture onto edge of adjacent.

CAREFULLY FIT the pieces in place, leaving narrow gaps between them. Cover the prints with paper and iron over the top to bond the pictures firmly to the mounting board. Do one or two prints at a time.



FINISHED MONTAGE shows the random shapes and white outlining that give the grouping a free-form appearance. Note how the careful cutting around the cat's head in the center photo breaks up the square lines of the other pictures and establishes a strong focal point of interest for the entire montage.



CONVENIENT SADDLEBAGS will pack up to 40 lbs. and are easily detachable. Even with maximum cargo, the bike's center of gravity is kept low for best handling.

Detachable saddlebags for your motorbike

By ROBERT L. COFFMAN

You can make your motorbike more useful for cargo-hauling with these inexpensive saddlebags. They're made from two plastic wastebaskets and aluminum framing

CARGO-HAULING CAPABILITY makes a motorcycle more useful, but to have it, you don't need a bulky box in the way when you're out riding for fun. This "saddlebag" accessory lets you carry a good supply of groceries, yet it can be removed in minutes. The cost is low.

The carrier consists of a lightweight aluminum frame supporting two rectangular plastic wastepaper baskets with slide-on covers. It weighs 4 lbs. without covers, 6 lbs. with. Loads up to 20 lbs. per basket can be carried, but capacity will depend on the strength of the rear luggage rack to which the frame is attached. By design, the center of gravity of the load stays low.

The frame shown was made from 1/16 x 1 x 1-in. and ½ x 1¼-in. aluminum angle stock, but 1 x 1-in. stock could be used throughout. Aluminum cold rivets, ⅛-in. dia. x ⅛-in. clinch, were used as fasteners. The two inner frame members were positioned to just span the rear luggage rack. This prevents side play. Frame members were cut to make outside openings just large enough for the wastebaskets. I found a tight fit is best; it keeps baskets from bouncing when empty and used without covers.

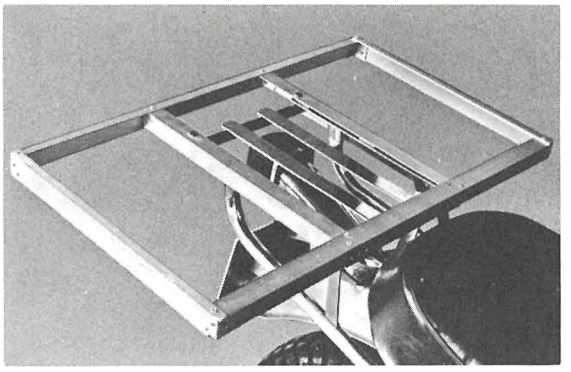
After assembly of the frame, all sharp corners were filed slightly round. Strips of adhesive-

SEE ALSO
Bicycles . . . Minibikes

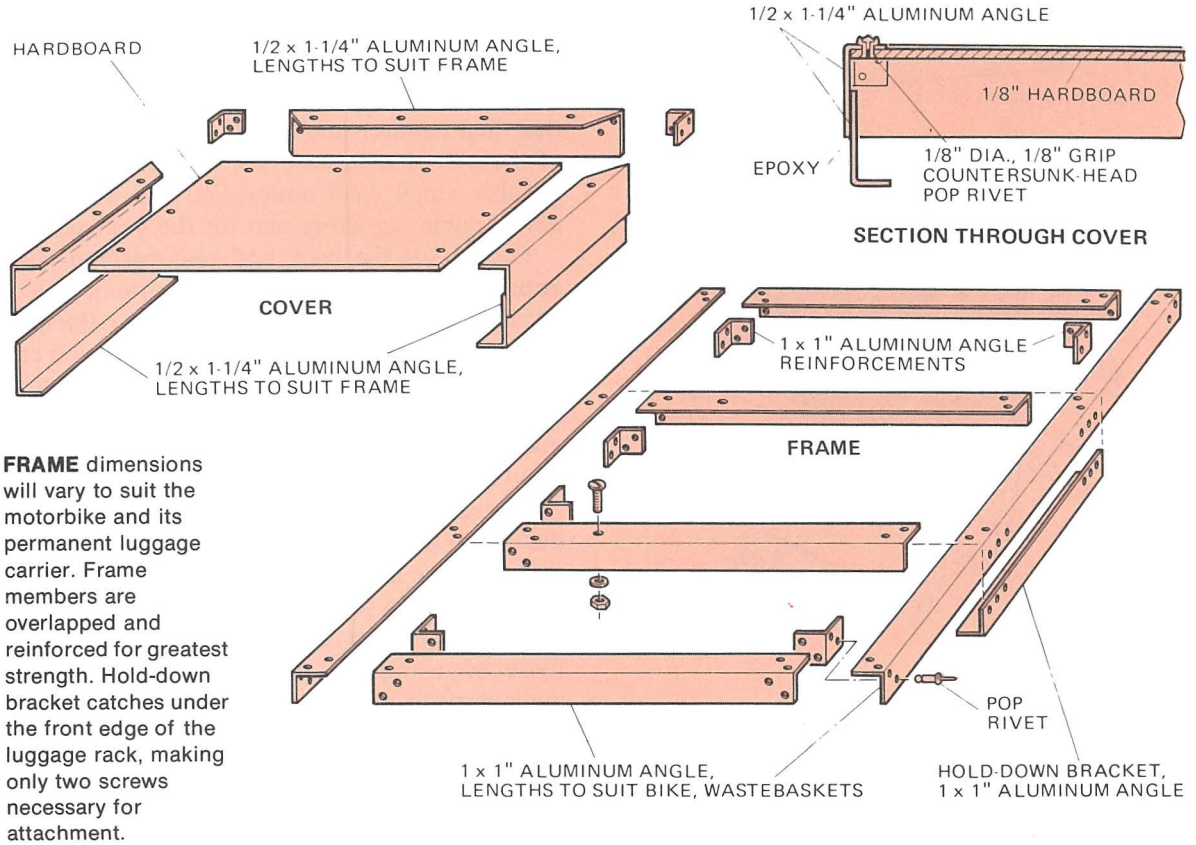
backed foam were affixed to the frame's underside—where it rests on the rack—to prevent rattles. Nuts are brazed or epoxied in place on the underside of the rack for the two machine screws that hold the frame to it.

Covers are optional, but if you decide to make them, use the same method as in building the frame, with the addition of ⅛-in. hardboard rectangles. Cold rivets fastening the board should be countersunk flush on the underside for smooth sliding. Extra lengths of ½ x 1¼-in. aluminum angle are bonded to the cover frames with epoxy cement to form channels that will slide over the main frame. Mating surfaces are roughened with sandpaper before cementing; if preferred, flush rivets can be used instead of epoxy.

In use, the covers are held in place by an elastic shock cord—the type commonly used with motorcycles and bicycles—of appropriate length stretched tight from side to side. A padlock can be used to secure either compartment or both, through matching holes drilled through cover and frame at front or rear; padlocks can take the place of the elastic cord.



THE ALUMINUM FRAME for the saddlebags attaches to a smaller luggage rack. The actual cargo compartments are Rubbermaid N2845 plastic wastebaskets.


HARDBOARD
1/2 x 1-1/4" ALUMINUM ANGLE, LENGTHS TO SUIT FRAME
COVER
1/2 x 1-1/4" ALUMINUM ANGLE, LENGTHS TO SUIT FRAME
1/2 x 1-1/4" ALUMINUM ANGLE
1/8" HARDBOARD
EPOXY
1/8" DIA., 1/8" GRIP COUNTERSUNK-HEAD POP RIVET
SECTION THROUGH COVER
1 x 1" ALUMINUM ANGLE REINFORCEMENTS
FRAME
POP RIVET
1 x 1" ALUMINUM ANGLE, LENGTHS TO SUIT BIKE, WASTEBASKETS
HOLD-DOWN BRACKET, 1 x 1" ALUMINUM ANGLE

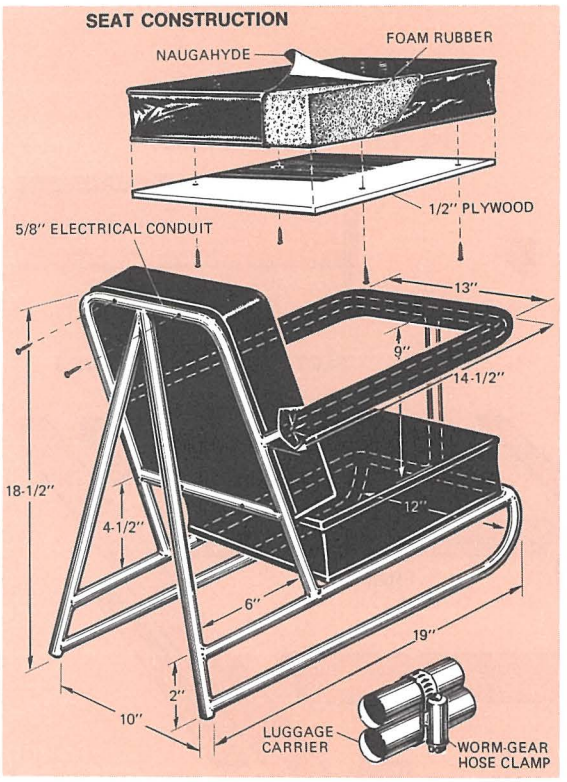
FRAME dimensions will vary to suit the motorbike and its permanent luggage carrier. Frame members are overlapped and reinforced for greatest strength. Hold-down bracket catches under the front edge of the luggage rack, making only two screws necessary for attachment.

Add a tag-along seat to your motorcycle

By LUGMAN HOUSE

Make the kids feel like a part of the family when you take them along on your next motorcycle ride. This sturdy little seat is attached over the back wheel for the ride of their lives

THE FRAMEWORK of the seat is made out of electrical conduit and painted to blend with your cycle.



QUITE OFTEN when a couple buys his-and-her motorcycles they don't count on the fact that their children might want to get in on the fun of those cool summer-evening rides. For a reasonably small cash outlay you can make this comfortable tag-along seat for the youngsters.

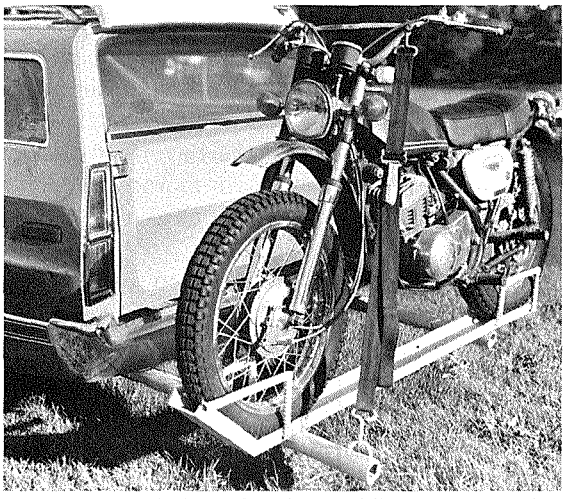
Except for the back and seat cushions, the entire framework is formed from common electrical conduit. Here a conduit bender (hickey) comes in handy, but even without one, you can bend the tubing without kinking it. Simply cork one end, fill the tubing completely with dry sand and cork the other end. After you've made the bends, remove the corks and pour out the sand.

Where one length of conduit joins another, file the end to fit the mating contour. For maximum strength, use silver solder for all the joints.

The back and seat cushions are pieces of ½-in. plywood padded with foam rubber. The Naugahyde covering will withstand a reasonable amount of sun and rain. To finish the framework paint it to blend with your cycle or to please your wife.

Worm-gear hose clamps are used to attach the seat to the luggage rack of the cycle.

SEE ALSO
Bicycles . . . Minibikes



THE CARRIER holds a 315-lb. trail bike—too heavy for bumper-mounted types. It slides into mounts or is bolted to the underframe and leaves the bumper unmarred.

A trail-bike carrier for your car

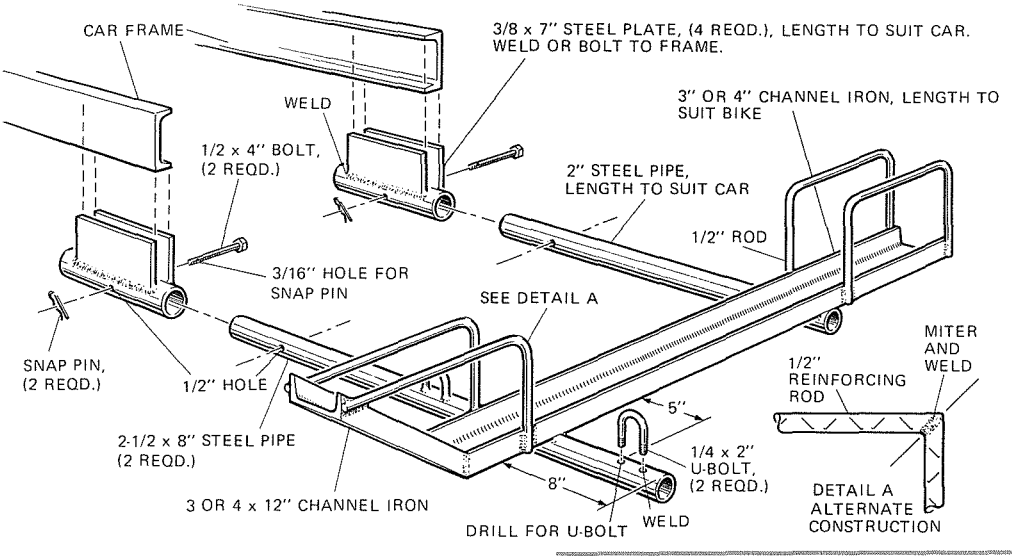
By DWAYNE L. HARLAN

Why leave your bike at home when you go on an outing? This handy detachable carrier lets you take your bike where the fun is

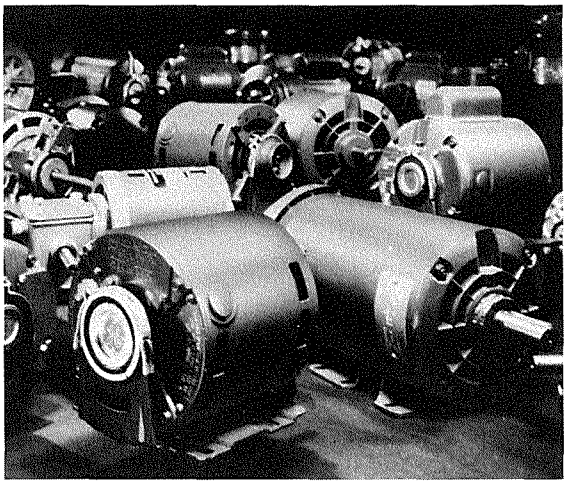
IF YOU HAVE A TRAIL BIKE that weighs more than 300 pounds, you can't use bumper-mounted brackets to carry it.

This sturdy, removable carrier will safely handle any bike your car's suspension can, and should cost less than $20 for materials. If you don't do the welding yourself, measure and cut the parts in advance and take them to a local welding shop. It shouldn't cost more than an additional $10. (Check for gas leaks before welding.)

Dimensions will vary, of course, to suit your car and bike. You'll also find the carrier strong enough to incorporate a trailer hitch (where permitted by law).


CAR FRAME
3/8 x 7" STEEL PLATE, (4 REQD.), LENGTH TO SUIT CAR. WELD OR BOLT TO FRAME.
WELD
3" OR 4" CHANNEL IRON, LENGTH TO SUIT BIKE
1/2 x 4" BOLT, (2 REQD.)
2" STEEL PIPE, LENGTH TO SUIT CAR
1/2" ROD
3/16" HOLE FOR SNAP PIN
SEE DETAIL A
SNAP PIN, (2 REQD.)
1/2" HOLE
MITER AND WELD
1/2" REINFORCING ROD
5"
2-1/2 x 8" STEEL PIPE (2 REQD.)
1/4 x 2" U-BOLT, (2 REQD.)
8"
3 OR 4 x 12" CHANNEL IRON
DRILL FOR U-BOLT
WELD
DETAIL A ALTERNATE CONSTRUCTION

SEE ALSO
Bicycles . . . Minibikes



A guide to electric motors

There are several important factors you'll want to consider when you choose a motor

WHEN YOU NEED a replacement motor for an appliance or workshop tool, ordering a new unit is easy enough—just take the necessary data from the motor's nameplate. But when you're scratch-building a worksaver like a bench saw, don't make the common mistake of selecting a motor by simply guessing.

Actually there are four factors you must consider before making a choice: horsepower rating, starting effort, shaft speed and operating voltage.

Horsepower is the primary consideration. As an indication of requirements for different jobs, the table on the opposite page lists motors of various horsepower and their typical uses. If your particular application is not listed, simply compare it to a similar job and select the next larger motor to avoid overloading.

Continual overloading of a motor above its rated power can cause it to overheat and shorten its life. For this reason, most new fan, blower, pump, compressor and conveyor motors have automatic-reset overload protection to guard against such overheating. It's important that the thermal protector automatically resets the motor in installations like a furnace blower, where you would not want the furnace to remain inoperative overnight, or on water pumps located away from the house. A manual-reset overload device, however, is recommended for motors that drive potentially dangerous tools, such as a saw, jointer or lathe.

Load moving is critical when you start a motor. Machines such as free-running saws or fans are easy to start. Others that must start under load—such as concrete mixers, conveyors, pumps and air compressors—need motors with extra turning strength, or torque, during the starting revolutions. For most home, farm and workshop uses, easy-to-start machines call for *split-phase* motors; hard-to-start machines require *capacitor-start* motors.

Split-phase motors have only moderate starting torque and are built with ratings up to 1/3 hp. Two windings, start and run, are energized at first. At about 80 percent of operating speed, a centrifugal switch cuts the start winding out of the circuit.

Capacitor-start motors, on the other hand, deliver two to three times the starting torque for the same amount of current. These are made with ratings from 1/6 to 3 hp. Since capacitor-start motors cost from 25 to 50 percent more than split-phase motors of like power, split-phase is the logical choice when the starting load is light (as on fans and blowers), or where the load is applied after the motor reaches full operating speed (drill press).

Both types use a single-phase power supply and, combined, make up about 90 percent of the motors in the U.S. Polyphase (usually three-phase) motors constitute the balance and are designed for continuous heavy-duty work. Because of the three-phase power requirement, however, polyphase motors are not often found in home workshops.

Most single-phase motors run at full load speeds of either 1725 or 3450 rpm. The faster motor is frequently the smaller of the two, and has a lower price per hp. When possible, this is the type to use since its speed can be reduced by a 6:1 belt-and-pulley combination.

With regard to voltage, a look at the motor's nameplate will tell you whether its rating corresponds to your power supply, which likely is 115 v.a.c., 60 cycle. The dual-voltage (115/230-v.), capacitor-start motors are available with ratings beginning at 1/6 hp, while split-phase motors are rated at 1/6 hp through ½ hp.

SEE ALSO

Bandsaws . . . Belt sanders . . . Bench saws . . . Drill presses . . . Jigsaws . . . Power-tool stands . . . Shapers . . . Wiring, electrical . . . Wood lathes

COMMON USES FOR ELECTRIC MOTORS

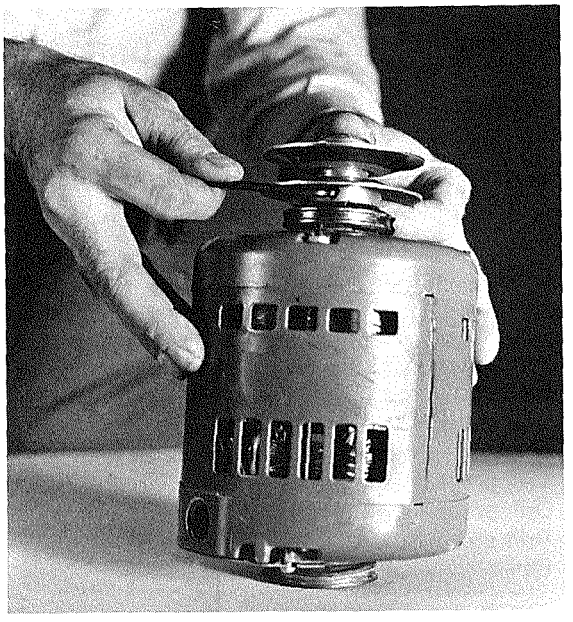
APPLICATION	HORSEPOWER	SPEED	MOTOR TYPE
Belt sander, 4″	¼	1725	Split-phase
Belt sander, 6″	½	1725	Capacitor-start
Belt sander, 10″	1	1725	Capacitor-start
Belt-driven blower	⅛-¾	1725	Split-phase
Churn	⅓	1725	Split-phase
Small compressor	1/6-¾	1725	Capacitor-start
Small concrete mixer	½	1725	Capacitor-start
Cream separator	½	1725	Capacitor-start
Drill press, ¼″	⅓	1725	Split-phase
Drill press, ½″	½	1725	Capacitor-start
Drill press, ¾″	¾	1725	Capacitor-start
Belt-driven fan	⅛-¾	1725	Split-phase
Feed mixer, 15-bushel	¾	1725	Capacitor-start
Feed grinder	¾	1725	Capacitor-start
Flexible shaft, 5/16″ dia. x 50′	⅓	1725	Split-phase
Flexible shaft, ½″ dia. x 75′	½	1725	Capacitor-start
Wheel grinder, 6″	⅓	1725	Split-phase
Wheel grinder, 7″	½	1725	Split-phase
Wheel grinder, 8″	1	1725	Capacitor-start
Jigsaw, 12 or 15″	¼	1725	Split-phase
Jigsaw, 18 or 25″	⅓	1725	Split-phase
Jointer, 4½″	½	3450	Capacitor-start
Jointer, 6″	½	3450	Capacitor-start
Jointer, 8″	¾	3450	Capacitor-start
Lathe (metal), 6″-swing	½	1725	Capacitor-start
Lathe (metal), 10″-swing	¾	1725	Capacitor-start
Lathe (wood), 8″-swing	⅓	1725	Split-phase
Lathe (wood), 12″-swing	¾	1725	Capacitor-start
Small meat grinder	¼	1725	Split-phase
Oil burner	⅛-¼	1725	Split-phase
Small paint sprayer	⅓	1725	Capacitor-start
Planer	¾	3450	Capacitor-start
Jet pump	⅓-2	3450	Capacitor-start
Sump pump	⅓	1725	Split-phase
Pump jack	½	1725	Capacitor-start
Bandsaw, 8″ throat	⅓	1725	Capacitor-start
Bandsaw, 10, 12 or 14″	½	1725	Capacitor-start
Bench saw, 6 or 7″	½	3450	Capacitor-start
Bench saw, 8″	¾	3450	Capacitor-start
Bench saw, 10″	1	3450	Capacitor-start
Spindle shaper	½	3450	Capacitor-start
Stoker	⅓	1725	Capacitor-start

Courtesy General Purpose Motor Dept., General Electric Co.

How to repair home workshop motors

By LEN HILTS

Very few things you own have the reliability and stamina of the typical home workshop motor. There are only a few things to go wrong and they are easy to fix



LOOK FOR a small setscrew at the base of the pulley and tighten it with an Allen wrench.

HOME WORKSHOP MOTORS, the kind you use to run table saws and drill presses, are among the most reliable machines in your home. With modest care, such motors will give years and years of trouble-free service. The care involves nothing more than a few drops of oil each month, if the motor has oil cups, and brushing dust and dirt and sawdust off of it.

If you took the case off of the typical workshop motor, you'd see an armature consisting of copper wires wound around a cylindrical rotor; and field coils of copper wire inside of which the armature turns. The armature and field coils are connected by carbon elements called brushes mounted in the commutator, an assembly of copper bars around one end of the armature shaft. One brush is positive and the other is negative. They are directly opposite each other, and are held in firm contact with the commutator by springs.

Thus the armature on its shaft is the motor's only moving part (except for the carbon brushes which push against the commutator). One reason for the great dependability of the workshop motor is the fact that it has very few moving parts.

SEE ALSO

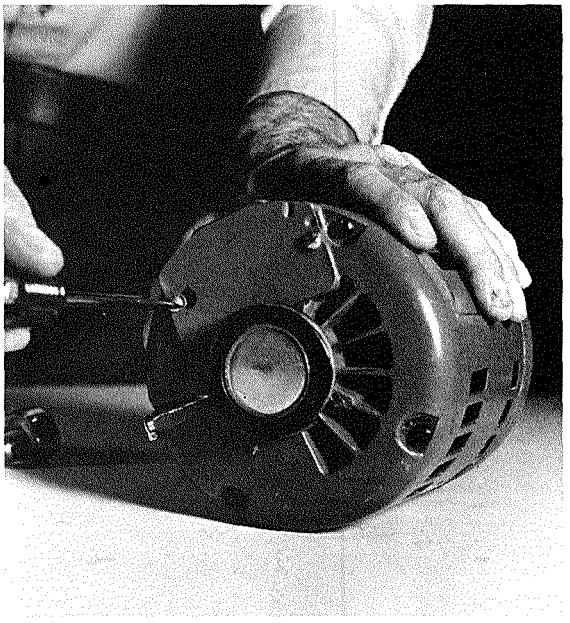
Apartment workshops . . . Bandsaws . . . Belt sanders . . . Bench saws . . . Drill presses . . . Power-tool stands . . . Wiring, electrical . . . Workbenches . . . Workshops

Here are some of the more common failures that occur in workshop motors:

1. A loose pulley. The pulley, of course, is not a part of the motor itself but is attached to the armature shaft. It is slipped over the end of the shaft and held in place by tightening a set screw. See the photograph above. If this setscrew loosens, the pulley may wobble or even work its way off the shaft. To avoid unexpected problems, check the setscrew occasionally. If it should be loose, tighten it by using an Allen wrench of the correct size. (If you don't have one, you can buy an inexpensive set of common-sized Allen wrenches at your home center.)

While you are inspecting the pulley, you should also check the drive belt. Belts are subject to wear and they may harden and crack with age. They also may stretch slightly so they're loose on the pulley. Test the belt by pressing down on it with your finger. You should be able to depress the belt about half an inch with moderate finger pressure. If it depresses more than that, the belt should be tightened. If you note cracks or badly worn places on the belt, replace it. To be sure of getting the correct replacement, take the old belt with you to the store.

2. A loose wire. If you find that your motor sometimes starts and sometimes does not, or if it emits sparks, you can suspect a loose wire. There are only a couple of wires which can be loose, and these are located, as a rule, under a



THE ACCESS PLATE on the end panel of the housing can be removed to tighten electrical connections.

WITH THE PLATE OFF, you have a clear view of any loose wires and can tighten all connections.

cover plate you will find on one end of the motor. The cover plate is held in place by two small screws. Remove these.

Before removing the cover plate, unplug or disconnect the motor from the electric power source. With the cover plate off, you can use a small wrench to tighten the connections. Then replace the plate and reconnect the motor.

3. Bad brushes. The brushes in a motor are small pieces of carbon held under spring tension against the turning commutator. They are subject to wear and may have to be replaced every few months in a motor which gets an exceptional amount of use, or perhaps every few years in a motor which gets only occasional use.

You can suspect worn brushes when the motor starts sluggishly or gives off sparks as it runs. Some motors have brushes contained in small housings under slotted caps. By carefully removing these caps, you can replace the brushes without disassembling the motor.

When removing these caps, turn slowly and lift away slowly, because the brushes under the caps are spring loaded. If you pull the cap away suddenly, the spring and the brush will fly out. Lift the cap slowly, allowing the spring under it to relax. Then lift the spring and brush out.

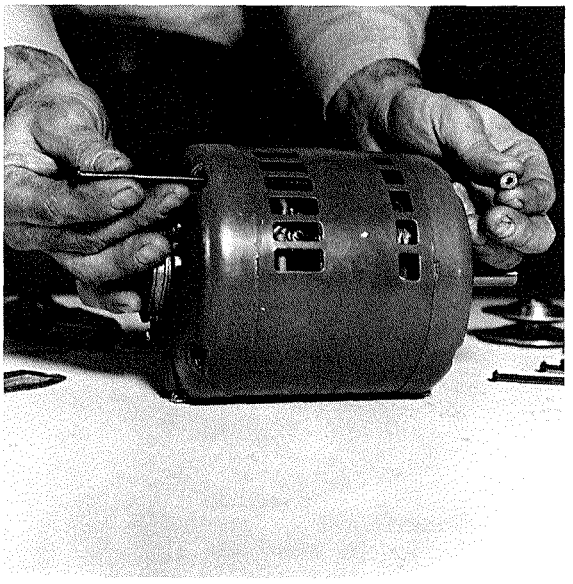
Check the spring as well as the brush, and replace both if necessary. You can buy springs and brushes at good hardware stores or at places which specialize in home power tools. To install the new brushes, simply insert them in the chamber under the cap, put the spring into the chamber, and then screw the cap into place. Always replace both brushes, positive and negative, at the same time.

In some motors, you must disassemble the motor housing to get at the brushes. Begin the disassembly by removing the pulley from the shaft. Then look for screwheads in indentations on the side of the housing. The housing is held together by long screws which extend through the motor. As a rule, there are four screws, secured by nuts at the other end. Use a screwdriver to remove these screws, being careful to hold the nuts as the screws are loosened.

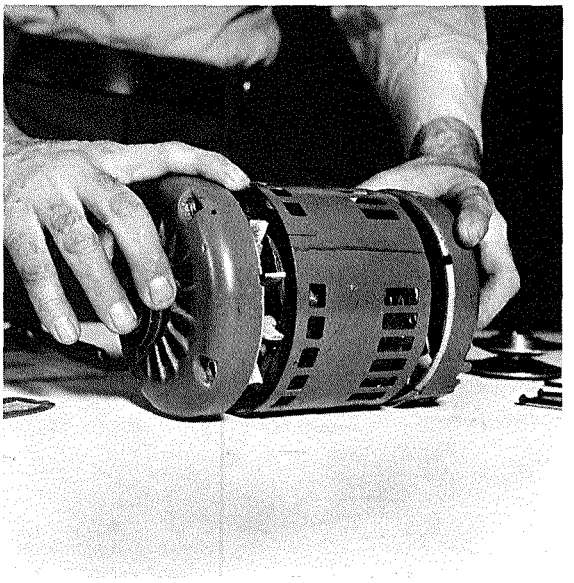
With the screws removed, you should be able to lift away both ends of the motor housing. If the ends stick, place a block of wood against each of them and tap it briskly with a hammer until the component loosens.

With the ends of the motor housing removed, you should see the brush holders at the commutator end of the armature shaft. The brush holders may be held in place by small screws or clips. Remove these and lift each holder off the motor, then remove from it the brush and brush spring.

As before, check the brush and the spring and replace both as necessary. Also, replace both the positive and negative brushes. Insert the new brush and spring in the holder, then put the hold-



THE MOTOR housing is held together by long screws and nuts. Remove the screws to disassemble.



PULL THE ENDS of the motor housing apart to gain access to the brush holders on the commutator.

er back in position on the motor with the tip of the brush in contact with the commutator.

4. Frozen bearings. Fortunately, bearings don't fail very often. The usual cause is lack of lubrication. Keep in mind that there are two kinds of motors in terms of lubrication. There are those which are lubricated at the factory and sealed, and never require any additional lubrication. And there are others which have tiny oil cups built in just over the main drive shaft. These little oil cups have spring-loaded caps on them to keep them closed, keeping dirt out. If your motor has these little cups, you must add several drops of machine oil regularly. If the cups run dry and the motor continues to run, you are risking frozen, burned-out bearings.

If the bearings burn out, you face an expensive repair job, one which you shouldn't attempt to do yourself. The professional mechanic and motor specialist has special pullers for removing bearings from the end cap. Without these special tools, you can easily ruin an otherwise repairable motor. Some do-it-yourselfers try to remove the end cap with a hammer to get at the bearings. It may work, but the risk of a ruined motor is great.

You sometimes can tell that the bearings are going bad when the motor begins to run noisily. In time, the bearings will freeze: The motor will hum when you turn it on, but it will not revolve. When that happens, remove the motor from the tool and take it to a professional repairman.

Operating tips. Keep in mind that the home workshop motor is a split-phase motor and that, as such, it draws a heavy electric current as it starts and for the first 10 seconds of operation. This is the reason that the lights in your workshop may dim momentarily when you start a motorized unit.

Under normal circumstances, this overload doesn't mean anything to the average homeowner. But there are two times when it can be very important.

One time is when all the current is shut off in the house as, for example, when the power company shuts down the power for an hour or two to make repairs. When the power is turned on again, everything electrical with its switch turned on starts immediately. If several motor-powered units are on—say the furnace blower, the washer, the dryer, and the refrigerator—all of these motors will be activated at the same time. This causes a great drain of power, since all of these motors draw so heavily in the first few seconds, and the usual result is a bevy of blown fuses.

The other time the heavy power drain caused by the starting of a home workshop motor is important is when you are operating several power tools on the same electric circuit. The electric circuit in your workshop is (or should be) a 20-amp. circuit, capable of carrying 2300 watts.

It is a good idea to know the wattage of each tool and accessory in your workshop, and to keep a mental total of how many watts you are drawing at any time. This way, you can anticipate overload problems.

Piggyback speed reducer

By WILLIAM WAGGONER

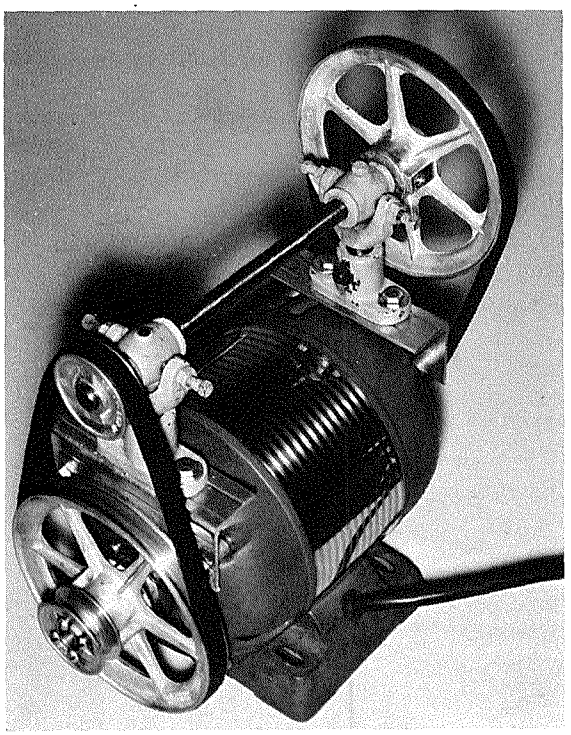
LIFT YOURSELF by your bootstraps?

That's what this novel piggyback speed reducer appears to do, for it cuts your 1725-rpm double-shaft motor to under 200 rpm, and with only *one* shaft.

The heart of the speed reducer is the 6-in. free-running pulley to which the drive pulley is bolted. It revolves freely and is driven through speed-reducing pulleys from the other end of the motor. To use the motor at normal speed, you just slip one belt and turn a setscrew.

To construct the piggyback, remove the top motor-housing bolts and replace the longer bolts. Sections of angle iron, shimmed out with spacers of ⅛-in. pipe, provide support for the hangers.

Many ½-in. motor shafts have a flat ground on the shaft. In this case epoxy a ½-in. bronze bushing over the shaft and use a ⅝-in. arbor pulley.



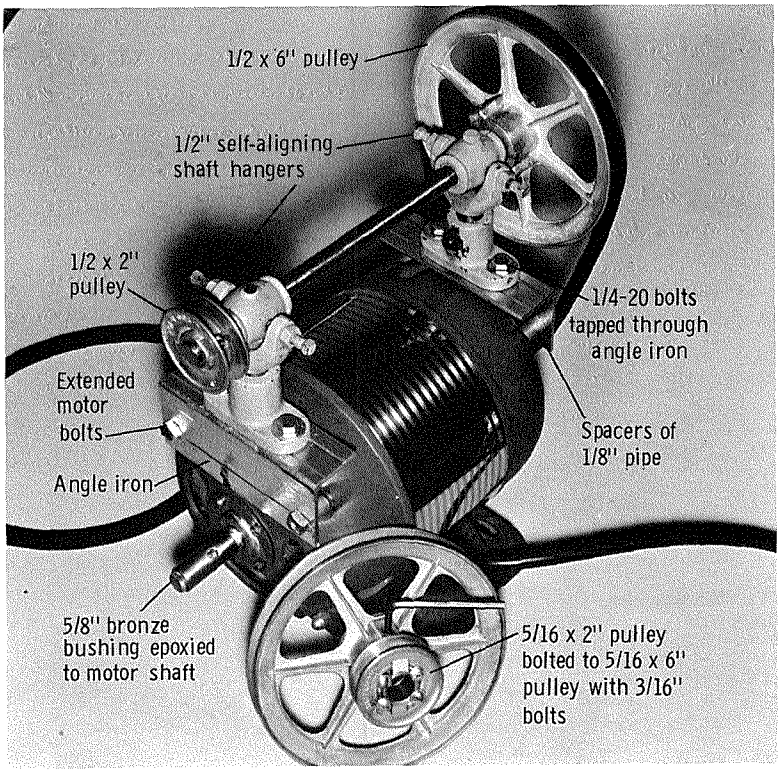
SECRET of the unique setup is that the large pulley (lower left) is free-running on the motor shaft.

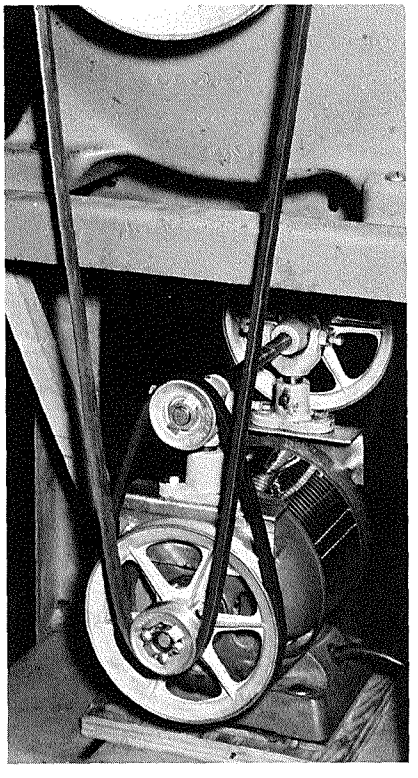
BRONZE BUSHING (below) is epoxied to a ½-in. motor shaft to enlarge the bearing surface for pulley.

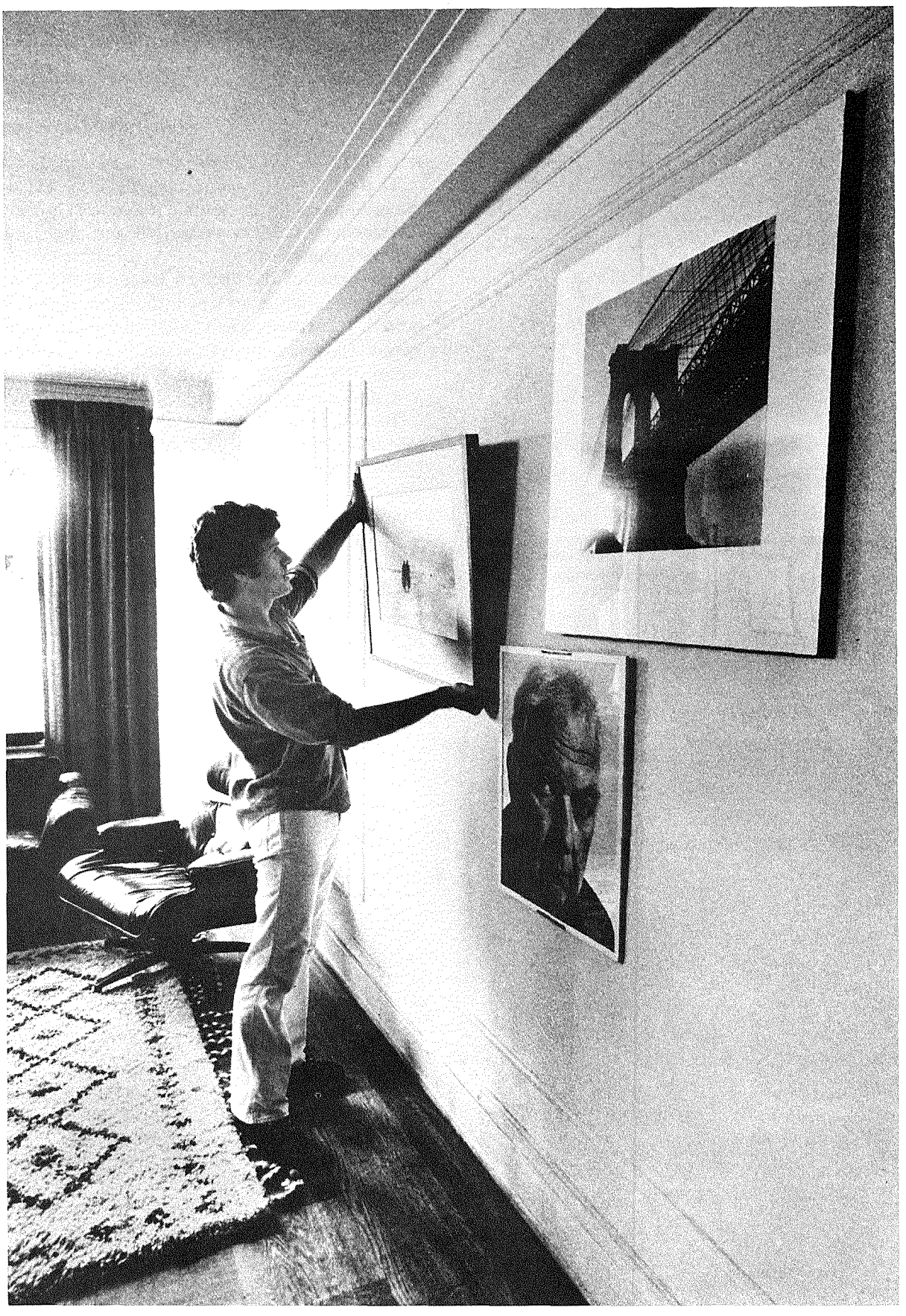
PIGGYBACK SETUP (below right) is ideal for cramped quarters, such as making your bandsaw a metalcutter.

SEE ALSO

Apartment workshops . . . Bandsaws . . . Bench saws . . . Cutoff machines . . . Power hacksaws . . . Power-tool stands . . .

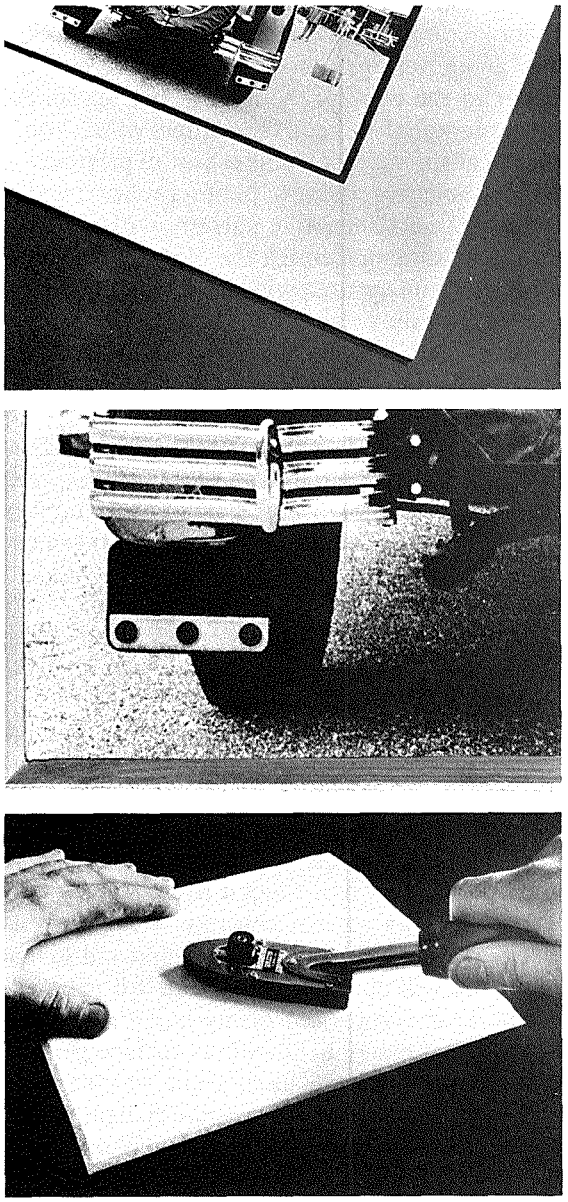

1/2 x 6" pulley
1/2" self-aligning shaft hangers
1/2 x 2" pulley
1/4-20 bolts tapped through angle iron
Extended motor bolts
Spacers of 1/8" pipe
Angle iron
5/8" bronze bushing epoxied to motor shaft
5/16 x 2" pulley bolted to 5/16 x 6" pulley with 3/16" bolts





How to mount your photo prints

Show off some of your most prized photos by mounting and protecting them. You can have a professional do it, but here are some hints and methods to help you do-it-yourself



MOUNTING TRICKS include centered-flush mounting (top; note black border around full-negative image); matting (above, center); use of "tacking iron" (bottom) to hold the tissue in place while mounting.

By DAVE SAGARIN

GOOD REASONS to mount your photo prints abound: Mounting makes a print thick and keeps it flat, which protects it against curling, cracking and rough handling. But mainly, mounting makes a print special. It shows that you think a lot of the picture, and want others to see it at its best.

Of the many ways to mount prints, the best, in my opinion, is dry mounting, using a press or hand iron to bond the print to a mount board. Dry mounting is permanent, handsome and fairly cheap.

The simplest way to get a print mounted is to have it done commercially at an art supply store, framer or custom photo lab. A typical price for flush-mounting an 8x10 print on illustration board is about $1.50. But if you have a friend at an ad agency, a corporate graphics department, or an art school, you may be able to use their press.

For dry-mounting at home, the first requirement is a clear work space large enough to lay out your supplies, cut mounting boards, and set prints out to cool. Cover your work surface with cheap board.

You can't mount a print that's tightly curled.

SEE ALSO

Cutting boards . . . Dryers, photo . . . Enlarging, photo . . . Frames, art . . . Montages, photo . . . Photo hints . . . Photography . . . Picture frames . . . Prints, photo . . . Trimmers, photo

SOME TYPICAL presses are the Technal 500 (top) and the Seal Junior 70 (left). Larger sizes cost more, such as the Technal Rollermount (above) which is basically a heavy, heated roller.

To flatten such prints, dampen them and redry them under pressure. A dry-mount press set at low temperature can speed drying and provide the pressure needed. If you stack prints as you press them flat, you need only dampen one out of three or four.

Cracks, stains, fingerprints and ripples (frilling) can mess up the edge of a print. To avoid these troubles when you're making prints you know you'll mount, center the image on a larger-than-normal size piece of printing paper, leaving a generous border all around that you'll trim.

For dry-mounting you need heat, pressure and dry-mounting tissue. The tissue is impregnated, like wax paper, with a meltable adhesive.

During the time it takes for your iron or press to heat, set the print on a piece of mount board and shift it around to decide what size the final mount should be, and where the print should sit on it.

basic methods

To my mind, there are three approaches to this: *Flush* mounting carries the image to the very edge of the mount, with no border; the print image fights its environment, a good technique for journalistic or other dynamic shots. *Centered* mounting is more formal, with a border (often a raised "mat") surrounding the image; usually both sides and the top are the same width, and the bottom is a bit wider, but some pictures seem to look cramped if you don't widen the top border. *Centered-flush* mounting runs the printing paper to the edge of the mount, but leaves the image centered; to keep the borders white, you'll need a cropping easel, unless you're printing the whole negative. Many photographers widen their enlargers' negative carriers with a file so that light shining through the clear film borders around the image area will leave a black outline.

You can now rough-trim it to within an inch of the area to be mounted. The mounting board should be cut to the same size as the rough-trimmed print for flush or centered-flush mounting; for centered mounting, leave generous borders. If you're going to frame or mat the print, make sure the mount board size is measured in whole inches to allow the use of precut frames.

measuring and cutting

To measure, use a rigid ruler and start at the one-inch mark, remembering to subtract one inch from the result.

For cutting, lay a heavy metal straightedge (other materials can be cut into) across the mount or print so the measurement dots just peep out from under its edge; a wide strip of masking tape stuck to the bottom of the straightedge will help keep it from slipping. Arrange the work so that you're in a comfortable position, with bright, nonglaring light and so that the blade will cut into waste area if it slips.

The best way to cut prints is with a single-edged razor blade, held with its surface perpendicular to the print and its edge entering the cut at about a 30° angle. Cut with a smooth, light touch.

To cut mount board, use a mat knife or a razor blade in a holder. Change blades frequently—dull blades tear as they cut.

Put print and board in the hot press about a minute to dry them out and reduce curl. Open the press at least once to let dry air in.

Cut a piece of dry-mount tissue the same size as the rough-trimmed print. Set the print face down and make sure it's completely clean and dust free—if you don't, you'll see how large a bump a tiny piece of grit can make. Put the tissue on back of the print and tack it down with a short stroke of the iron from the center of the print toward one corner, to keep it from shifting. Don't press hard, or you may leave a ridge in the print. A tacking iron (drawn toward you, not to its point) made for this is best, but you can also use a corner of a mounting press or the tip of a clothes iron

use the right heat

Your iron should be just hot enough to tack the tissue, not hot enough to melt the tissue over the iron. Practice on waste stock, first, waiting a few minutes after each heat-setting change.

Now that they're tacked together, trim print and tissue to the exact edge of the image you want to see. Position the trimmed print on the board by eye, moving it until you like the way it looks. Then check with the ruler that the side borders are equal and the print is square to the board edge. Gently lift the untacked corner of the print, and slide the iron underneath to tack the tissue to the board: If you have a mounting press, protect the face of the print with a sheet of clean, smooth, porous paper and insert the covered print into a sandwich of mounting boards or hardboard till the sandwich is thick enough for the press to apply maximun pressure.

To set press temperature properly, start with a medium heat, insert a single-weight, nonresin-coated scrap print tacked to a two-ply mount board, close the press without locking it, count five seconds, then remove. The print should lie flat, with its edges lifted, and should peel off when the board is flexed. If it doesn't lift off, the press is too hot; if it doesn't even flatten out, it's too cold. Once you find the right temperature setting, a permanent mounting should take about 15 to 20 seconds with the press locked shut. Thicker, glossier and larger things require higher mount temperatures and longer times; RC prints and special tissues recommended for them require lower temperatures and shorter times.

If you're using a clothes iron, use it dry (no steam), set it to "synthetic" and use the low-temperature RC-type tissues. Preheat the print and mount individually by covering them and slowly ironing all over. Trim and tack as above. To mount, iron one swath at a time, heating first by ironing gently from the center toward one edge for several passes before pressing firmly. Keep the iron moving, and don't let the cover sheet shift. Check each as it is completed. Work toward each edge, then toward the corners. When mounting is finished, the print should lie perfectly flat.

Ridges and bubbles in the mounted print may be eliminated by reinserting in the press or reironing, first with gentle pressure to heat the affected area thoroughly, then with very high pressure to flatten it down.

The tissue is soft when the print comes out of the press; to reduce edge-lifting, cool it under the pressure of piles of books with newspapers protecting the print.

Mount boards come in several types from art supply stores and large stationers in a variety of sizes, finishes, colors and substances.

Illustration board, a quality paper surface on a pulp core, is the choice for most work. Thicker, four-ply board is better than two-ply for large mounts or when the print will get a lot of handling. Museum board is a premium type whose composition varies: The best is 100-percent natural cotton fiber throughout, but there are also cotton-faced pulp-core boards, and boards faced with acid-free sulphite. Your board and pictures will last longest with 100-percent cotton board.

You can also use a piece of photographic printing paper, fixed and washed and mounted back-to-back with your print.

matting

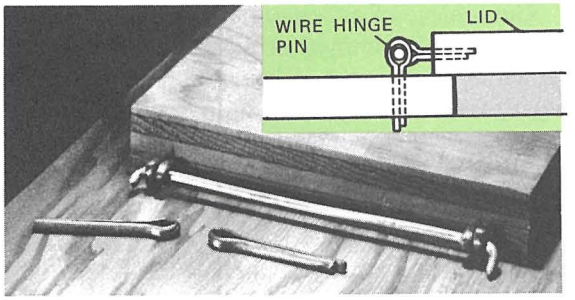
For wall-hung prints, try a mat. The mat's color and texture act as moderators between the image and the wall—you're freer to experiment with colors, here, as you can always throw the mat away.

Cutting a mat takes skill and special tools—you may prefer to have it done by a professional framer. If you do it yourself, be sure to measure precisely: First measure the image area and the exact distance from each edge of the image to the nearest edge of the mount. Sketch these on paper. Now cut the mat board to the exact size of the mount, lay it face down, and mark hole dimensions of the sketch, top to top, bottom to bottom, but reversing the sides.

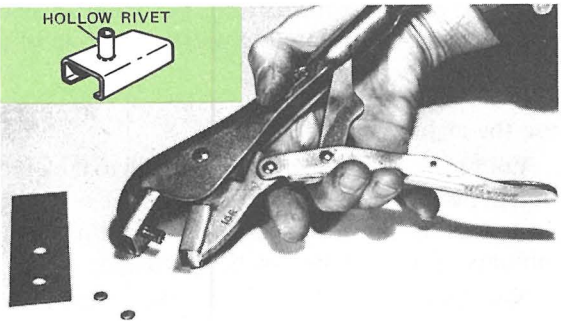
After cutting the mat, if its surface is dark in color, darken the newly cut edges with a felt pen.

The print is now ready to be framed, but if you're going to hang it with clear plastic framing or edge clips, bind the mat and mount together with Mystik tape.

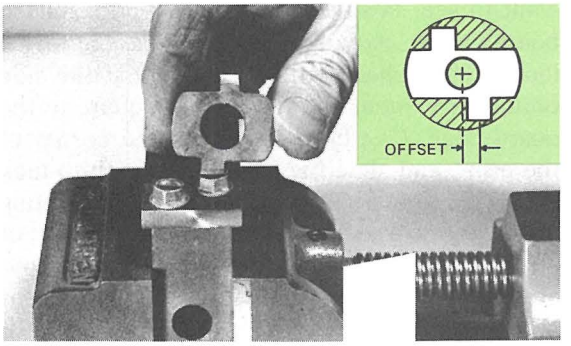
A SERVICEABLE HINGE for a box lid can be made from four or more cotter pins and a length of wire which passes through their eyes. The pins are driven tightly into pre-drilled pilot holes, and positioned so their eyes overlap like the knuckles of a regular hinge. The ends of the wire hinge pin are bent at right angles to lock it in place.—*Walter E. Burton, Akron, OH.*



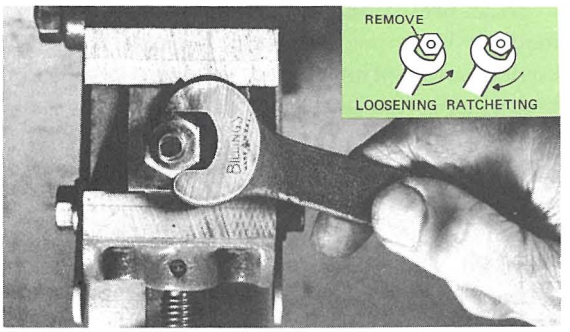
A STRONG HAND PUNCH can be improvised from Vise Grip pliers and a hollow rivet, when your regular hand punch won't do the job. Sharpen the end of the rivet with a rosehead countersink and insert it through a metal clip. Slip it over the Vise Grip jaw, with a pad of sheet lead over the opposite jaw to protect the rivet.—*Peter Legon, Malden, MA.*



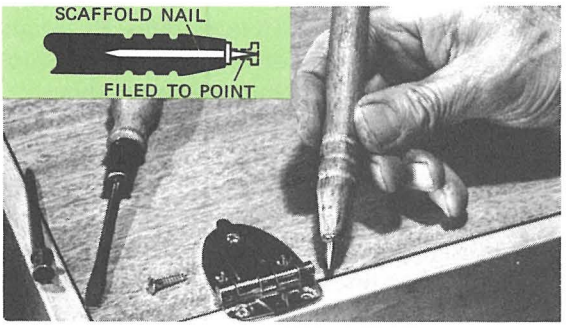
POCKET SCREWDRIVERS made from large washers are standard equipment for many mechanics. The edges of the washer are filed to leave stub blades that fit the screw slots. Rather than file the stub blade in the center of the washer as is usually done, I suggest offsetting the blades for greater leverage when you turn the screw. A tool-steel washer works well.—*B. W. Ervin, Kent, OH.*



THIS MODIFIED WRENCH will provide a fast "ratcheting" action on a nut. Grind off and round one jaw of an open-end wrench as shown. The wrench will then be able to slip over corners of the nut until the continued swing of the wrench causes the jaw to grip succeeding flats on the nut as it is tightened. For a loosening action, the wrench is flopped.—*H. Miller, Vallejo, CA.*



THIS PILOT-HOLE 'AWL' is a handy homemade tool made from a double-headed scaffold nail. While drilling pilot holes for wood screws works well in hardwood, screws hold better in softwood when the fibers are forced aside. To make the awl, file the first nailhead to a point, the second head prevents the point from going too deep.—*Thomas E. Louis, Dobbs Ferry, NY.*

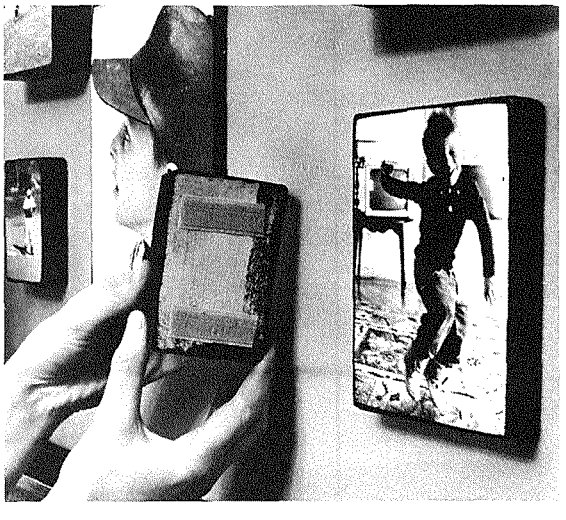


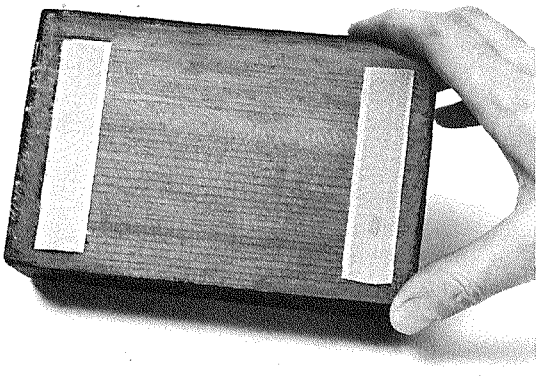
Add 3-D to your photo display

Simple snapshots mounted on wood blocks create an unusual wall decoration that's easy to make

By HARVEY SHAMAN

SMALL STRIPS of Velcro tape on back of each block make it easy to arrange pictures on panel covered with matching Velcro. Blocks stick firmly and can be quickly removed and rearranged.





continued

SEE ALSO

**Enlarging, photo . . . Frames, art . . .
Montages, photo . . . Photo hints . . . Photography . . .
Picture frames . . . Prints, photo . . . Trimmers, photo**

■ ORDINARY SNAPSHOTS take on a dramatic appearance when you mount them on blocks of wood, producing a three-dimensional relief effect. By varying the size and thickness of the blocks, you can create an unusual random-pattern wall display of pictures that otherwise get stored away unseen in a bureau drawer or photo album.

The blocks are standard wood thicknesses—¼-inch, ¾-inch (1-inch nominal) and 1⅝ inch (2-inch nominal). Three basic sizes accommodate 8x10, 5x7 and 4x5 prints. You can, of course, make the blocks any other sizes you wish depending on how you want to crop your shots. Trim off the borders and mount the prints on the blocks with a white wood glue (don't use rubber cement as this will bleed through, staining the prints).

The blocks are painted flat black to give a sense of depth and contrast. After the prints are cemented on, trim their edges flush with a sharp knife or razor blade and sand them smooth with fine abrasive paper. Then touch up the paper edges with a black felt-tip marking pen so they blend in with the blocks and become invisible. Arrange the blocks on a backing panel of ¼-inch plywood or hardboard. This can be edged with picture-frame molding or 1x2 strips to create a shadow-box effect to enhance the 3-D look of the photos.

The display panel shown here incorporates an added feature that makes the blocks easy to mount and rearrange. It's based on the use of Velcro—the two-part, self-adhering material sold as a substitute for zippers and buttons on clothing. One part consists of thousands of tiny nylon loops and the other part has hook-shaped fibers that catch in the loops. When pressed together, the two stick firmly to each other, yet can easily be pulled apart.

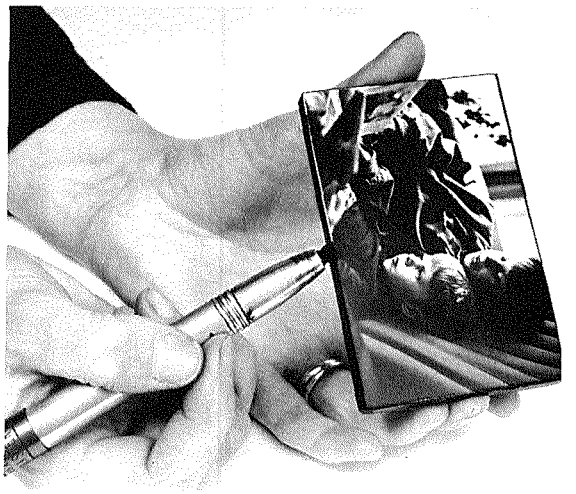
The looped Velcro is cemented to the display panel and strips of the matching hooked material are fastened to the backs of the blocks. All you do is press the blocks onto the Velcro-covered panel and they stay by themselves. You can move them around to change the arrangement or add new blocks whenever you like.

Velcro comes in black, white, gray and various colors. The looped material is 48 inches wide and sells for about $12 a yard. Cut in half, one yard will cover two 2x3-foot panels—a handy size for wall display. The matching hooked material comes as a tape ¾ inch wide for about $1 a yard. Special cements for mounting both types are also available. Velcro supplies are sold at many department stores, sewing centers and fabric shops. They are distributed by Maharam Fabric Corp., 130 W. 46th St., New York, N.Y. 10036 or 1113 S. Los Angeles St., Los Angeles, Calif. 90015.

If you don't wish to use the Velcro, you can attach the blocks with either screws from the rear or glue. In this case, lay out the blocks on the display panel in a flat position and make sure you have a pleasing arrangement before permanently mounting them.

MATERIALS for photo display include ¼-inch panel, wood blocks of assorted sizes, self-adhering Velcro material, special Velcro adhesive, trimming knife and a small brush for spreading glue.

BLACK MARKING pen touches up edges of prints so they blend in with black-painted blocks. Run tip along the corners, slanting pen backward so that it can't slip and mar the faces of the prints.



Get your power mower ready for spring

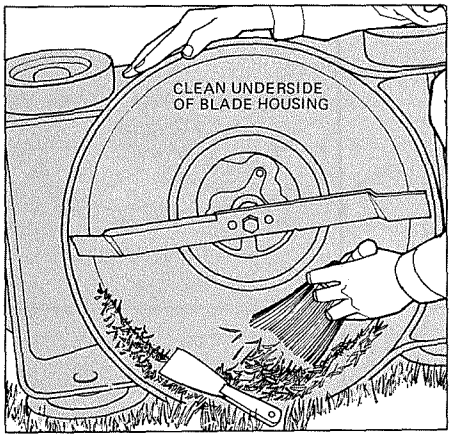
■ IF YOU SIMPLY PUSHED your power mower into a corner of the garage last fall after its last mowing session, it's time to be thinking about a spring-cleaning job to ready the machine for the season ahead. Overheating, hard starting, internal engine wear and other serious problems will result if dirt trapped under, on and inside your power mower isn't cleaned away. It takes some effort to have a mower that's ready for use any time: The information on these pages will make that task less troublesome because it covers the nitty-gritty of spring tune-ups.

Start inspection with the blade. A common problem is vibration caused by unbalanced blades. To check balance, remove blade and insert a screwdriver in the mounting hole. Hold the screwdriver vertically; if blade is unbalanced, blade will tip. Using a fine-grit grinding wheel, remove a little metal from the heavy end. If grinding doesn't balance the blade, replace it.

CLEAN COOLING FINS

The engine of a power mower is cooled by circulating air through fins inside the blower housing. If these fins become clogged and the airflow is blocked, the cooling process will be impeded or stopped completely. Overheating and damage to the internal parts can and will result. To clean the cooling fins, remove the blower housing and use a clean, dry paintbrush to brush dirt from between the fins. Packed-in dirt first can be loosened with a screwdriver.

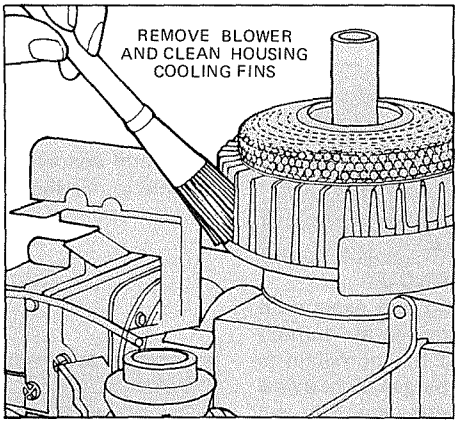
If dirt is stubborn, use a commercial degreaser and a narrow, stiff-bladed scraper to clean out the fins. Fins should be cleaned periodically during the season.

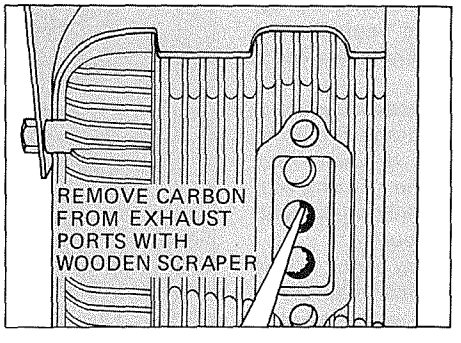


THEN CLEAN UNDERSIDE OF BLADE HOUSING

Often, because grass is moist when cut, the underside of the blade housing becomes clogged with layers of dried-on grass. If you failed to turn the mower over and clean the blade housing with a putty knife and whiskbroom after each cutting session, the task will be somewhat harder now. After each cleaning, also turn the machine right-side up and wipe the body exterior with a soft, clean cloth. A spray automotive-engine degreaser can be used to dissolve stubborn dirt and grease.

Now pay special attention to the carburetor linkage and choke-plate pivots. To clean these units, use a spray-type automotive-carburetor cleaner that's available at auto supply outlets. Then apply a drop of oil to the moving parts. Finally, remove the wheels, thoroughly clean the hubs and axles, and then coat the axles with a layer of an all-purpose grease.





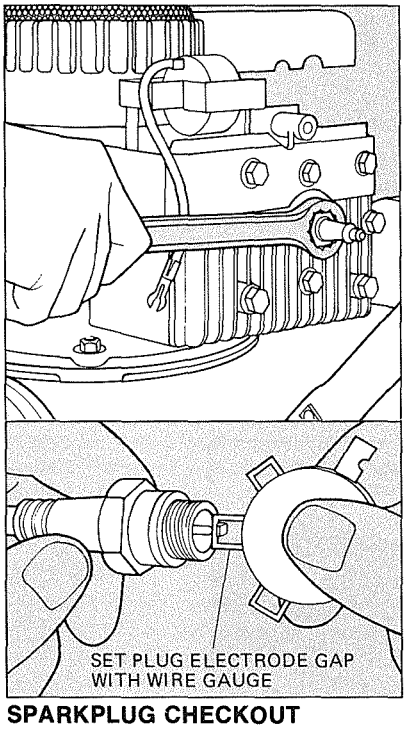
EXHAUST PORTS

Carbon is also a form of dirt, and an accumulation of it in the exhaust ports of power-mower engines (two-cycle engines, in particular) will reduce the power output appreciably. Before scraping off the carbon, exercise the precaution of first removing the sparkplug from the engine (to prevent the engine from starting). Then remove the muffler.

Next, turn the crankshaft slowly by means of the starter cord or self-starter until the lower part of the piston covers the ports. In this way, carbon will be kept out of the cylinder when its scraped loose.

SEE ALSO

Engines, small . . . Landscaping . . . Lawns . . . Snowblowers . . . Snowplows . . . Storage buildings . . . Tractor lifts . . . Tractor trailers . . . Trees . . . Yard machines



SPARKPLUG CHECKOUT

Remove the sparkplug and examine it carefully. If the electrodes are burned away or pitted, or if the porcelain is cracked, discard the plug and get a new one of the same designation. You will find the designation printed on the plug. Generally, 100 operating hours should be considered as maximum life for a plug.

If the plug looks fine, use a penknife or small wire brush to scrape dirt from around the electrodes. If you have a compressor, complete the cleaning with a blast of air. Lacking this equipment, blow out particles by mouth.

Whether the plug is new or not, set the electrode gap to the manufacturer's specification with a wire-type, sparkplug gauge like the one shown above. If you've lost the owner's manual and don't know the gap specification, for two-cycle engines gap is set at .028 to .033 in.; for four-cycle, it's .025 to .028. Insert plug and finger-tighten. Then, give an additional half turn with a wrench.

Inspect the sparkplug lead wire. If it is not too badly frayed or damaged, you might be able to patch it with insulating tape. Otherwise, you will have to get at the coil to replace it; in some machines, this means removal of the flywheel—a job best left to a professional. Sometimes, the lead wire is connector-fastened to the coil so that it can be replaced with the coil left in place.

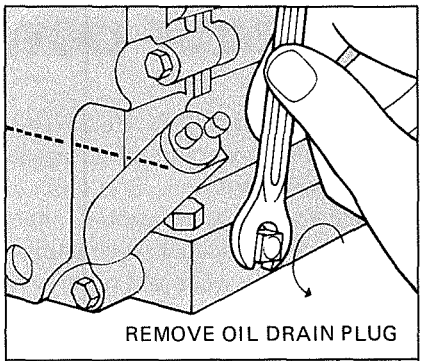
In other mowers, the wire is molded to the coil: To make the change, both wire and coil must be replaced.

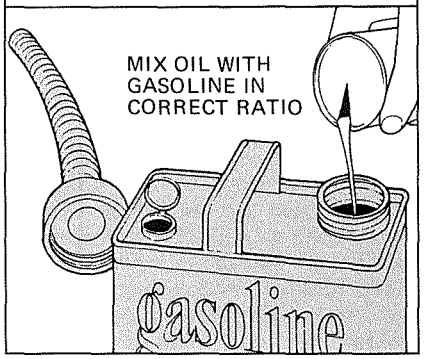
FUEL-OIL MIXTURE

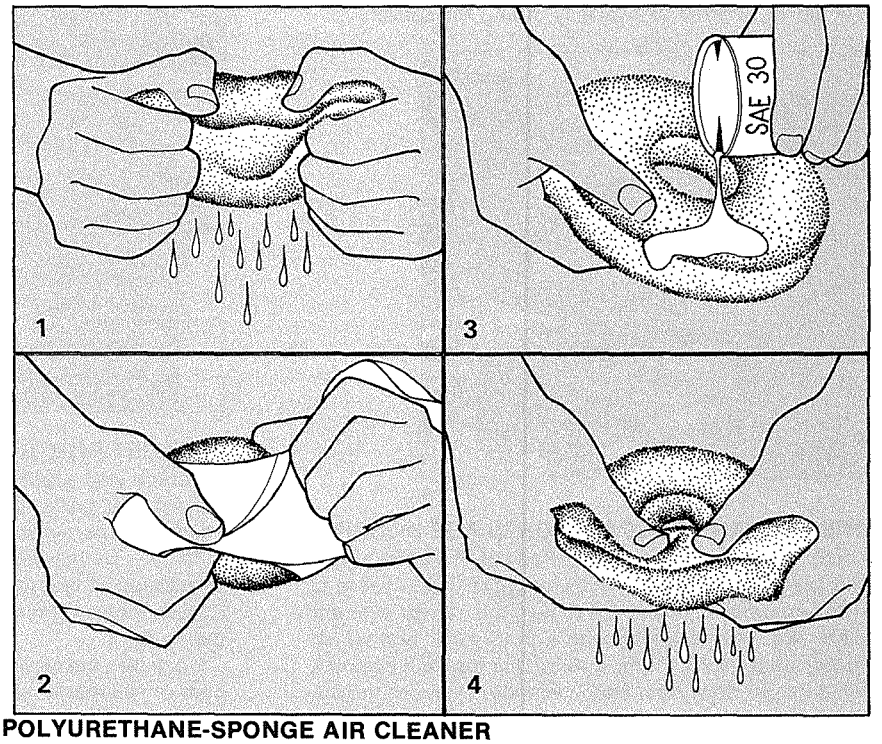
If your power-mower engine is four-cycle, warm it up, then shut it off. Remove the oil drain plug and drain the dirty oil into a waste pan. Replace the drain plug and fill the crankcase through the oil filler to the level mark. Use the type and weight of oil specified in your owner's manual.

In two-cycle engines, a mixture of oil and gasoline is used in the fuel tank. Improper fuel-oil mixture is the main cause of operational problems with two-cycle engines, so check the owner's manual for the correct ratio. (The correct mixture is usually ½ pint to 1 gallon gasoline.) The oil should be of the type and weight specified in the owner's manual or of the type made especially for two-cycle engines.

Insufficient oil in the mixture means that engine parts will be improperly lubricated, resulting in overheating and seizure. Too much oil causes engine smoking, loss of power and sparkplug clogging. So take the time to mix the fuel properly.

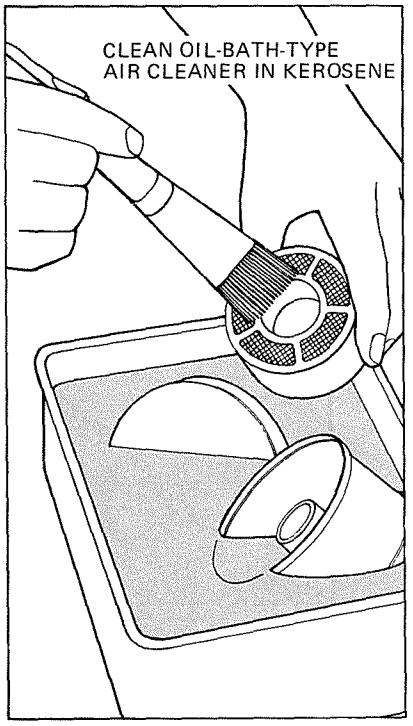






POLYURETHANE-SPONGE AIR CLEANER

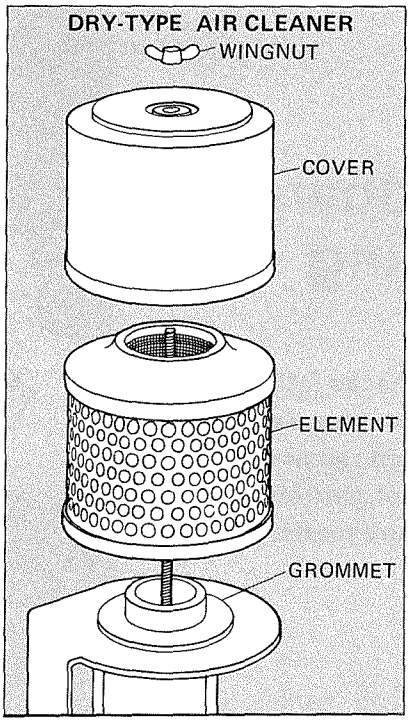
An air cleaner is the primary protection a power mower has from dust particles that can get inside to clog moving parts. One common type of air cleaner has a polyurethane-sponge element as shown in the drawings above. To clean it, (1) wash element in liquid detergent and warm water, (2) wrap in a cloth and squeeze dry, (3) saturate with SAE 30 engine oil and (4) squeeze to remove excess oil. Clean the container that holds the element, replace the element and cover lightly.



OIL-BATH CLEANER

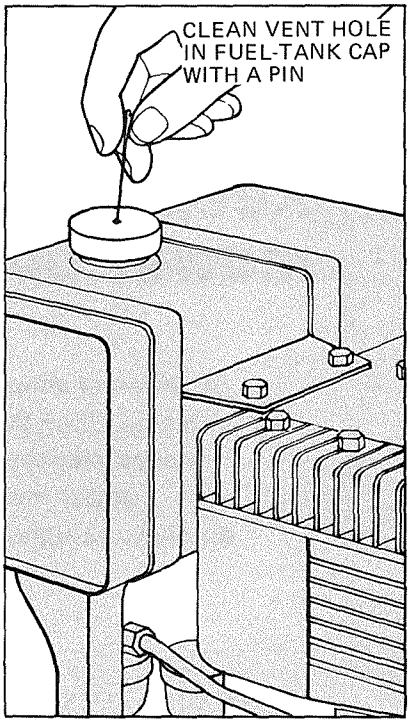
This type of air cleaner comes with a container that uses a layer of oil to trap dirt and dust particles.

To clean it, remove air cleaner from the engine and disassemble. Dump out the dirty oil and wash all the parts thoroughly in a solvent such as kerosene. Let these parts air-dry; then reassemble them and fill the cleaner to the level mark with a clean SAE engine oil.



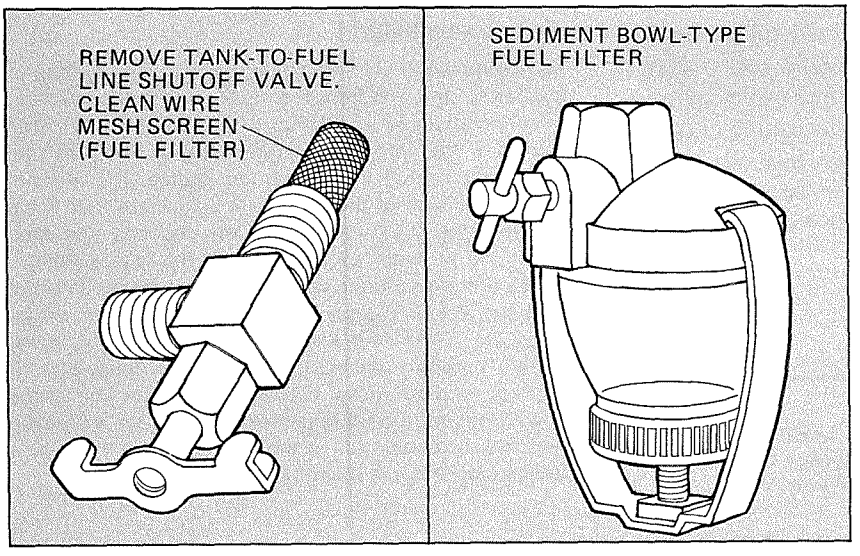
DRY-TYPE AIR CLEANER

With this type of air cleaner, unscrew the cover as shown above, take out and examine the filter element. If the element is paper, replace it. If it is metallic, carefully tap it on a flat surface to loosen dust and dirt. Then wash it thoroughly. Finally flush the element (from the inside out) with water until the water that comes out of the sides of the element looks clean. Allow the element to dry.



FUEL-TANK CAP

Some fuel-tank caps have a small vent hole. If it becomes plugged, a vacuum is created that will stop the flow of fuel and the engine will stall. Remove cap and clean out dirt in the hole with a pin. *Take care not to enlarge hole.* In addition, be sure that only proper fuel is poured into the fuel tank (pure gasoline or a correct mixture of oil and gasoline).



FUEL FILTER

Remove the fuel filter from your power mower and wash it thoroughly in kerosene, or let it soak in engine degreaser. The filter in many small engines is located in the tank-to-fuel-line shutoff valve. Remove the valve to get at the filter (far left).

Other engines have a sediment-bowl-type fuel filter that houses a ceramic element. Remove the bowl. If there is gasoline in the tank, be sure to first turn off the shutoff valve. Disassemble the filter and wash the parts in kerosene. If you're using engine degreaser, soak all parts for an hour or two; then wash in water and dry with an air-pressure hose which also blows away dirt.

Keep your power mower purring

A series of simple checks locates any problems. Then this sensible sequence makes diagnosis and repair of your power mower or yard tractor an easy, straightforward matter

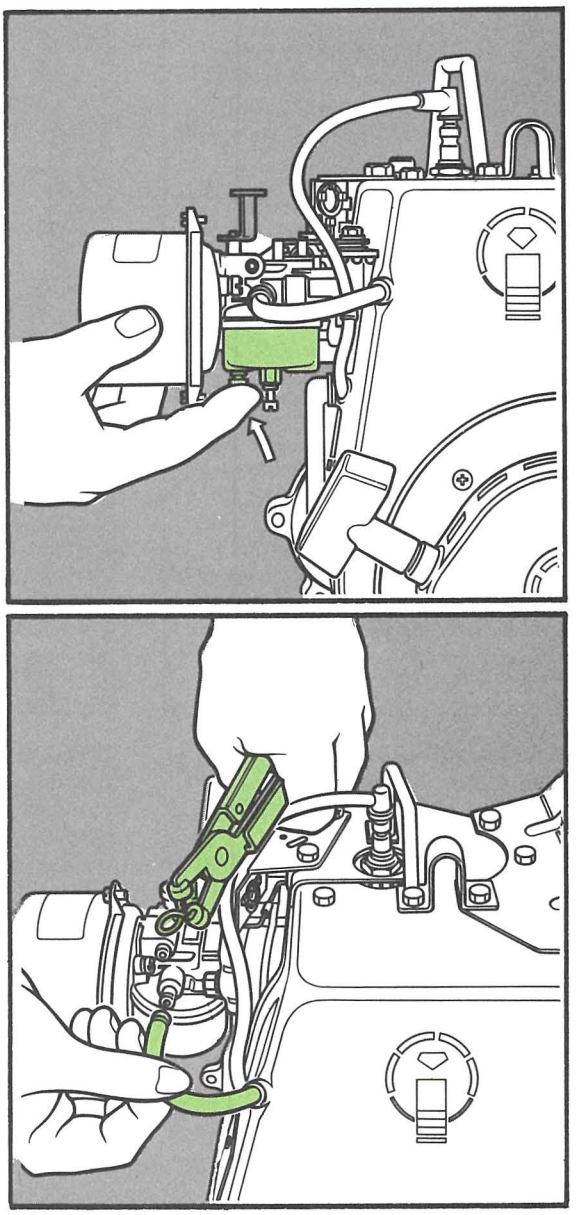
■ FAILURE TO START, hard starting and stalling are common mid-season problems that strike gasoline-powered lawnmowers and tractors. The most common causes include lack of compression, lack of or too much fuel in the cylinder, and no spark.

But a major reason for trouble can often be averted by knowing the difference between four and two-cycle engines: In four-cycle engines, ignition occurs with every fourth stroke of the piston. Four-cycle engines burn straight gasoline and possess a separate lubrication (oiling) system. It is imperative that gas and oil *not* be mixed.

In two-cycle engines, ignition occurs every second stroke of the piston. The engine runs on a mixture of oil and gasoline, and failure to mix the correct proportions of gas and oil *properly* is the single greatest cause of trouble (other than sparkplug failure). If yours is a two-cycle engine, consult the owner's manual to determine correct proportions and what kind of gas and oil is recommended. Gas and oil should be thoroughly mixed in a clean container *before* you pour it into the fuel tank.

SEE ALSO

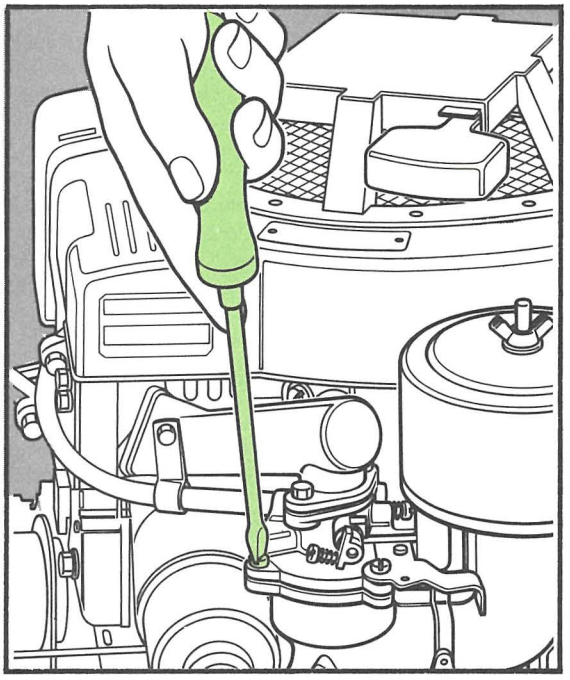
Engines, small . . . Landscaping . . . Lawns . . . Snowblowers . . . Snowplows . . . Storage buildings . . . Tractor lifts . . . Tractor trailers . . . Trees . . . Yard machines

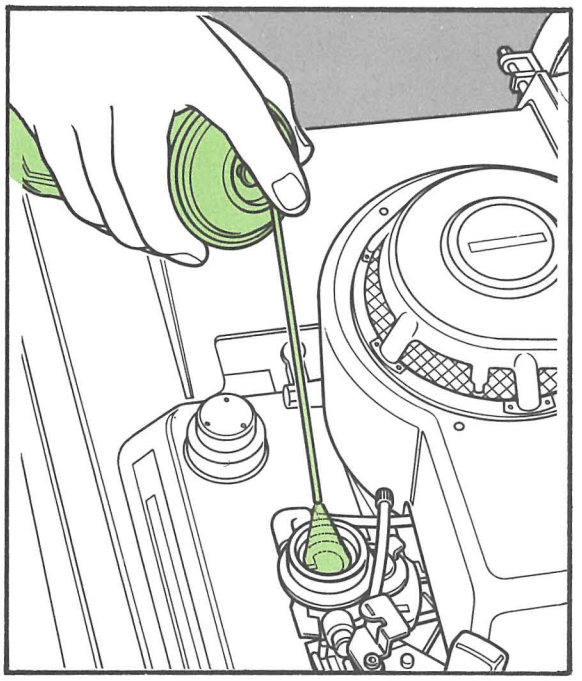


Engine won't start

An engine won't start or will stall if fuel isn't getting to the carburetor, and from the carburetor to the cylinder. First, remove the sparkplug and inject two or three squirts of fuel into the cylinder using a clean oil can. Reinsert the plug and crank the engine. If it doesn't start, the cause of the trouble is elsewhere, but if the engine does start, runs for a few seconds and then stops, the problem will be found in the fuel system.

See if there's a drain valve in the base of the carburetor bowl. Press it (top). If no fuel leaks, there's an obstruction in the fuel line or fuel tank. If fuel leaks, there's probably an obstruction in the carburetor. If there is no drain valve, disconnect the fuel line at the bowl (bottom). If no fuel comes out, look for a blocked fuel line or obstruction in the fuel tank. If fuel leaks, a fouled carburetor is probably the cause





Blocked fuel line

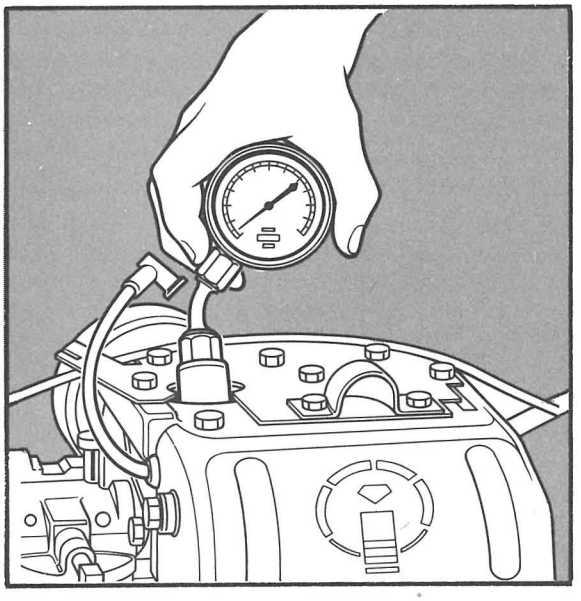
If the fuel line is blocked, the first step is to check for contaminated fuel. Let some fuel drop into your hand; if water and dirt remain after the gas evaporates, dump all fuel and wash the fuel tank thoroughly with kerosene. It may also be necessary to clean the fuel line and carburetor.

To trouble shoot when fuel isn't getting to the carburetor:

- Replace a bent or clogged fuel line.
- Tighten all carburetor bolts, fuel-line connections and fuel-pump housing (if present) because air leaks destroy the vacuum necessary to pull fuel to the carburetor.
- Clean choke linkage and choke-plate pivots; repair damaged choke parts. Lack of choking action will make the engine hard to start; a choke stuck in the closed position will flood the engine and prevent starts.
- Clean or replace a dirty fuel filter. One kind is a wire-mesh screen in the fuel line shutoff adapter; other engines have filter bowls.
- Replace the fuel-pump diaphragm if it has any holes.
- Clean clogged screens of fuel pipes that extend from the carburetor into the fuel tank of diaphragm-type carburetors (those without separate fuel pump).

If fuel is not getting from carburetor to engine:

- Clean the air cleaner to reduce flooding.
- Lightly tap the bowl of a float-type carburetor with a screwdriver to loosen a stuck needle valve.
- Adjust the carburetor. Back out the idle-mix screw one turn from finger-tight. Turn the speed screw *in* one turn from where it first touches the throttle lever.
- Last, strip and clean the carburetor thoroughly.



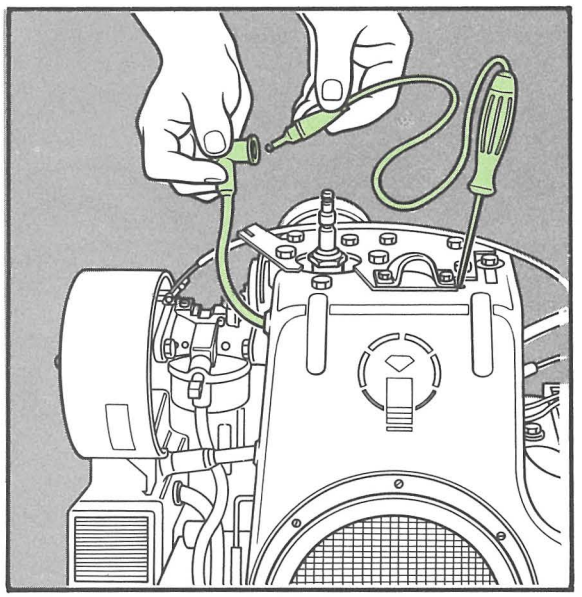
Inadequate compression

Stated simply, compression is the ability of the piston to compress the fuel/air mixture. Inadequate compression leads to hard starting and loss of power. Poor compression results when a cylinder is scored, piston rings stick or wear, valves stick or wear, or the crankshaft oil seal is damaged. The pressure loss reduces compression, which makes ignition more difficult.

One obvious sign that there is compression loss is a sloppy manual starting cord. If the cord offers little resistance and doesn't snap back, then sufficient compression is questionable.

An accurate check can be made with a compression gauge. Remove the sparkplug, insert the gauge fitting firmly, and crank the engine until the gauge reaches its maximum reading. The *minimum* compression of two-cycle engines is 60 psi; of four-cycles of 4½ hp or less, 65 psi; and of four-cycles above 4½ hp, 70 psi.

Compression loss may be caused by a loose sparkplug. Seat the plug by hand and give it one-half turn with a socket wrench.



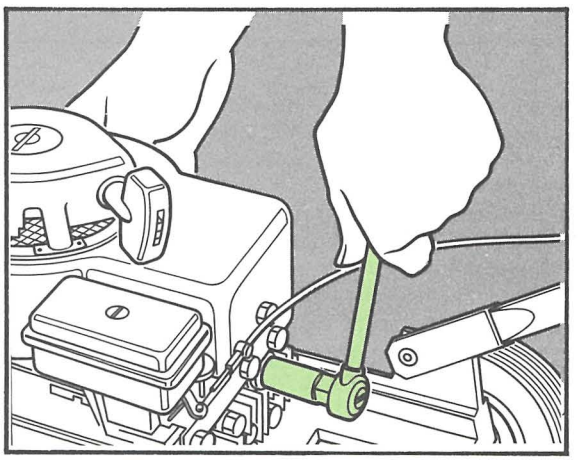
Garden tractors

Garden tractors with high-horsepower engines usually have transformer-coil ignition systems that are like those in cars, but must powermowers use a magneto system. Magnetos make their own electricity by a magnet-equipped flywheel that revolves around stationary field coils.

You can test a magneto system by gapping either a 14-mm or an 18-mm sparkplug to 5/32-3/16-in. Attach it to the sparkplug lead and ground it against the cylinder head as you crank the engine. A blue spark should jump the electrode gap.

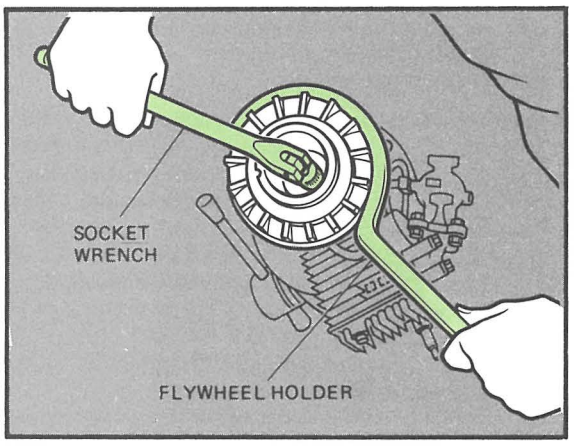
The same test can be made of a transformer-coil ignition system, but use the engine's sparkplug at its normal gap.

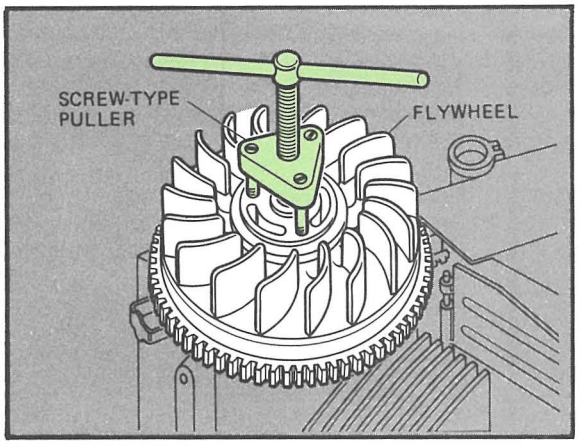
Use a spark-intensity tester for checking breakerless systems (left). Disconnect the lead from the sparkplug and attach the tester to the lead's metal terminal. Touch the test instrument's probe to a ground as you crank the engine. The test light will flash if the system is operating properly.



About sparkplugs

The sparkplug is one of the biggest single causes of engine problems. First, check the owner's manual to make sure you're using the right one. Then make certain the plug lead is connected tightly to the plug terminal, and to the magneto or coil output. If the lead's insulation is cracked, replace the lead. Buy a new sparkplug if the insulator is damaged or if electrodes are worn, burned or heavily coated with carbon or oil. Carbon on a plug usually means an engine is operating on an overly rich fuel mixture or that the ignition output is below par; oil on electrodes usually means that piston rings or valve stems (four-cycle engine) are worn; burned electrodes indicate that the engine is probably overheating.





Magneto repair

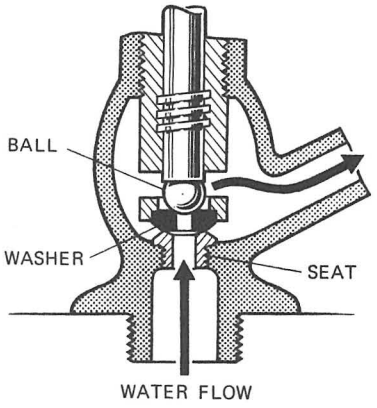
To repair a magneto ignition you have to remove the flywheel. On most two-cycle engines, first remove the flywheel nut. Some of these nuts have a right-hand thread; others, left-hand. If the flywheel moves as you turn the nut, hold it fast with a flywheel holder. With the nut off, it can usually be removed. On most four-cycle engines, hold the flywheel with a flywheel holder as the flywheel nut is removed. Install a knockout puller, hold the flywheel firmly, and rap the puller with a hammer to jar the flywheel loose.

What kind of faucet?

Recently I took apart a leaking faucet, thinking that it needed a new washer. A ball about ½ in. in diameter dropped out of it along with the washer, which was in pieces. Now I'm at a loss to know how to reassemble the parts. What goes where and what kind of faucet do I have?—A. Ashley, Salem, Ore.

According to your description you have a type of compression faucet. The ball, seated loosely at the bottom end of the stem, bears against the washer as shown in the illustration below.

The purpose of the ball is to effect a tight closure without turning the washer against a fixed seat. Replace the washer and parts as shown. While you have the faucet apart, it's a good idea to replace the packing to prevent possible leakage at the stem.



Those sweating sashes again!

Our home has steel casement sashes that sweat. Last winter, the water wet the frames, sills and the wall underneath, staining the plaster and loosening the wallpaper. The house is only one year old and we must find some way of preventing this damage. Can you tell us the cause and remedy?—C.E., Ala.

Ever notice the beads of moisture that quickly collect on a glass tumbler filled with cold water or a beverage on a warm summer day? Water collects (condenses) on the frames and panes of the sashes for precisely the same reason that it collects on the tumbler. The surface of the latter, cooled by its contents, is colder than the air with which it is in contact. Moisture in the air surrounding the glass is cooled to the dew point and condenses on the surface. The air in your rooms is warm and moisture-laden; the sash is relatively cold. Thus condensate forms on the frames and panes.

Most steel sashes can be provided with tight-fitting storm sashes and this usually solves the problem. The storms must fit tightly so there is no leakage of warm air into the space between the sashes. If your heating equipment is gas-fired, be sure it is properly vented to the outside.

Spotted faucet

I have hard water (no softener) and I've tried just about everything to clean the spotting off my new chrome-plated kitchen-sink faucet. Those horrid spots defy all my efforts and cleaners! Please, will you suggest something I can use without wearing myself out?—Mrs. Charles Wilson, Ottawa, Ill.

Must be you haven't tried cider vinegar. It takes some rub-a-dub with a soft cloth, as do most cleaners, but usually clears off the spots with minimum effort. Rinse off the vinegar residue after each cleaning with a soft cloth and wipe dry.

This is not a preventive; the spotting will come back. But if you wipe the plated parts dry after each use it will lengthen the time between periodic cleanings with the vinegar. Use it full strength, by the way.

"Burned" concrete

Last summer I poured a 15-ft.-long concrete walk, using a recommended mix. Now the walk is disintegrating and the surface is powdery. No salt has been used on it to thaw ice. What did I do wrong?—R.Y., Mass.

Assuming you poured the walk over a tamped gravel bed and troweled the surface in approved fashion, perhaps you did the job on a hot, dry and windy summer day, and the new concrete "burned out"—that is, it cured too quickly.

What to do? Break up the old walk and pour a new one, keeping it damp for *at least* 72 hours. Cover the walk with burlap, straw or anything else that will hold moisture after it has been wet down.

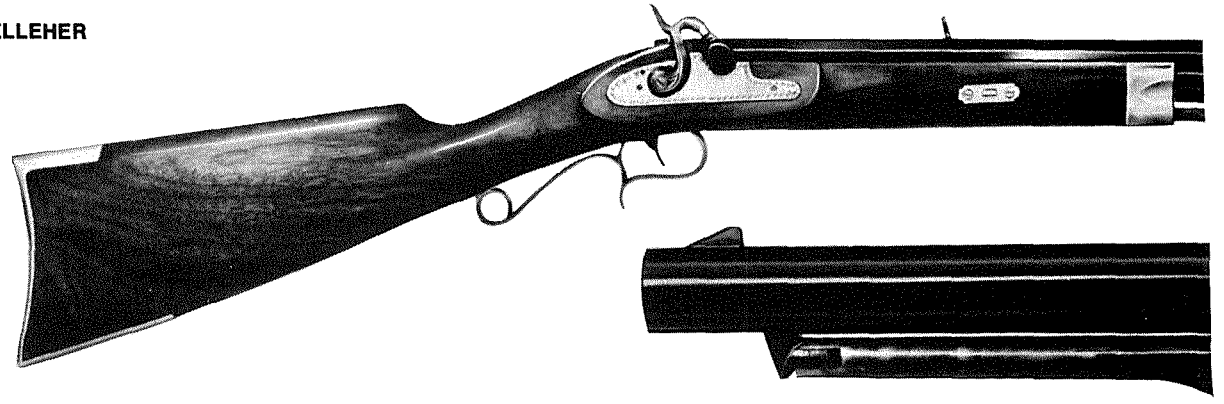
Derusting old tools

I've acquired some old tools, planes, chisels and the like, and the metal parts are rusty. What's the easiest, best way to take off the rust?—E.L., Fla.

There really isn't any "easy" way and the "best" way depends largely on the extent and depth of the corrosion. Surfaces deeply pitted are almost hopeless—unless you literally grind away the metal to obliterate the pits. Surface rust can be removed with a fine abrasive or an abrasive pad such as Scotchbrite. Chemical removers also are quite effective.

by W. Clyde Lammey

By JOE KELLEHER



The old art of muzzleloading

IN THE 100 YEARS after the founding of the United States, the black powder muzzleloading rifle was the principal weapon of the military and an essential tool for settlers moving west. These rifles put meat on the table for generations of Americans, held off the Indians and knocked down marauding grizzlies. The old charcoal burners finally got pushed aside by the introduction of the metallic cartridge, but recently they've been making a smoky comeback to the shooting scene.

Until a few years ago, shooters had to rely on a dwindling supply of original models if they got bit by the muzzleloading bug. These original guns have not only become increasingly expensive, but neglect and lack of replacement parts have made many of them much less than reliable. Today, however, some of the finest flintlock and percussion rifles ever made—plus a full line of accessories—are being produced again. You can have your pick from a range of target models, with adjustable sights, to authentic copies of famous military and hunting rifles.

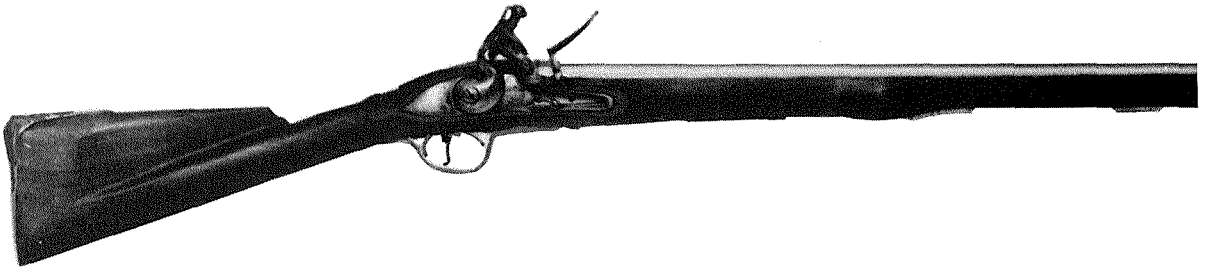
SEE ALSO

Ammunition . . . Gun cabinets . . . Gun racks . . . Guns . . . Hunting . . . Marksmanship . . . Shotguns

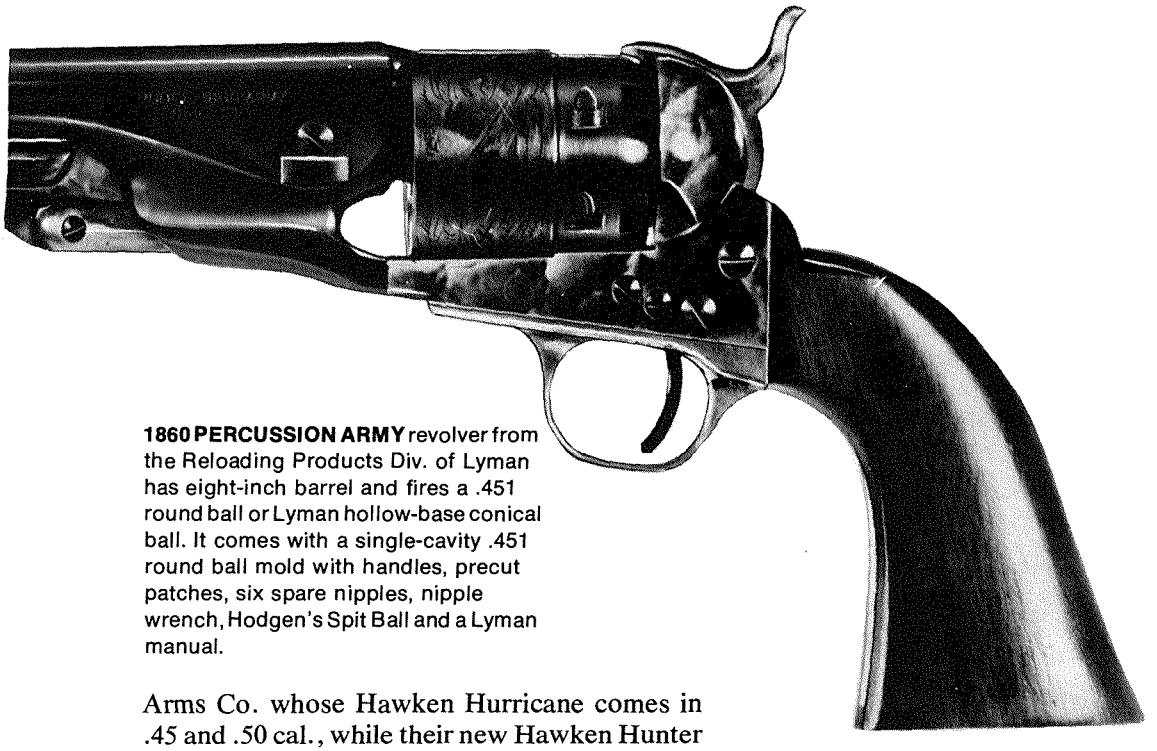
One of the most popular muzzleloaders sold today is a Hawken, produced by Thompson/Center Arms Co. The original of this rifle was made, starting in 1822, by the Hawken brothers in Saint Louis for fur traders and explorers pushing westward. This half-stocked rifle, weighing 8½ pounds, has a 28-inch octagon barrel with 12 lands and grooves.

Available in .45 or .50 cal., the model has polished brass trim on the butt plate, fore-end cap, ramrod fittings, patch box and trigger guard. Open hunting sights are micrometer-adjustable to simplify sighting in. Double-set triggers enable the shooter to squeeze off consistent 1½-inch, five-shot groups at 50 yards. A caplock and a flintlock version are being made. With either model, Thompson/Center offers an accessory pack with bullet mold, package of patches, powder measure, short bullet starter, powder solvent, extra nipple and nipple wrench—all for one low price which is well worth it for the beginner.

Hawken rifles are also produced by the Navy



HAWKEN HURRICANE, in .45 or .50 cal., and the Hawken Hunter in .58 cal. with a magnum ignition system and micrometer-adjustable open hunting sights are both modeled after the Hawken brothers' fur-trader rifles of the 1820s. They are now made by Navy Arms who claim you will get four-inch groups at 100 yards from benchrest.



1860 PERCUSSION ARMY revolver from the Reloading Products Div. of Lyman has eight-inch barrel and fires a .451 round ball or Lyman hollow-base conical ball. It comes with a single-cavity .451 round ball mold with handles, precut patches, six spare nipples, nipple wrench, Hodgen's Spit Ball and a Lyman manual.

Arms Co. whose Hawken Hurricane comes in .45 and .50 cal., while their new Hawken Hunter is an elephant gun magnum in .58 cal. that has been tested on African safari.

For the military buff, Lyman offers the .58-cal. 1863 Zouave of Civil War fame. A natural for those interested in the War Between the States, the Zouave was claimed to be the most accurate military rifle of its day. With careful loading and practice, it can produce surprisingly tight groups or knock down the heaviest U.S. game. It's from Lyman, and a small additional cost will bring you a kit with .58 Minié-ball mold, spare nipple, nipple wrench, bullet lube and Lyman's Black Powder Manual.

REVOLUTIONARY LAND PATTERN "Brown Bess" musket is a ready-to-shoot 42-inch 10½-pound replica from Lyman Products for Shooters. The gun is .75 cal. Graduated Powder Measure of solid brass (at right) adjusts to hold up to 120 grains of black powder in 10-grain increments. It is manufactured by Michaels of Oregon.

The Kentucky long rifle, often called a squirrel gun, was a favorite of famous frontiersmen. Hopkins & Allen has reproduced a fine model called the Minuteman. Available in flintlock or percussion, the full-stocked 55-inch rifle has a 39-inch octagonal barrel bored for .36 or .45-cal. balls. The 9½-pound Minuteman is ready to fire, or comes as a kit. All metal parts in the Hopkins & Allen kits are ready to be fitted. Only a rasp and sandpaper are needed to finish the stock, which is machine inletted, drilled and fully formed.

Building your muzzleloader is fun, but the real challenge is shooting. Each shot fired from a charcoal burner is a test of your skill as a loader as well as marksman. Accuracy with either flint or percussion rifles depends on careful fitting of the patched ball to the bore, and then carefully ramming the ball down onto the measured charge of black powder in one smooth stroke. For smaller bore rifles of .45 cal. and under, the patched ball is best. But the big-bore weapons, .50 cal. and up, can produce accurate results with hollow base bullets called Minié balls. Loaded without a patch, the lubricated Minié has a cavity in the base that expands to engage the rifling in the bore.

Loading technique starts with drying the bore with a clean patch and snapping off a percussion cap or two to clear the nipple. Set the butt on the ground with the muzzle pointed away from you and pour a measured amount of powder down the barrel. Lubricate a precut patch with saliva and lay it over the muzzle. Place the lead ball in the bore with the sprue pointing up. Using a short ramrod called a ball starter, push the ball into the bore until it is flush with the muzzle. Trim off any excess patch with a sharp knife and push the ball into the bore using the starter. Then switch to your ramrod and seat the ball on the powder with one smooth, uninterrupted stroke. Banging or tamping the ball can result in a de-

A .22-CAL. model for boys and beginning shooters, the RMAC breech loader makes a single-shot first rifle that can fire up to 250 shots for about $1. Breech turret holds ball and only the correct safe load of powder and cap. Sear safety blocks hammer until turret locks close. Traditional black powder rifle is by Rocky Mountain Arms. Old English muskets, arranged for antique auction at right, are valuable but more dangerous to fire than modern replicas.

formed ball, a compressed powder charge or an air space between the ball and the charge. Deformed balls are inaccurate, compressed powder often misfires and an airspace can cause a bulged or split barrel.

Now with the charge and ball seated, put the hammer on full-cock and press a cap on the nipple. You're set to take aim and fire.

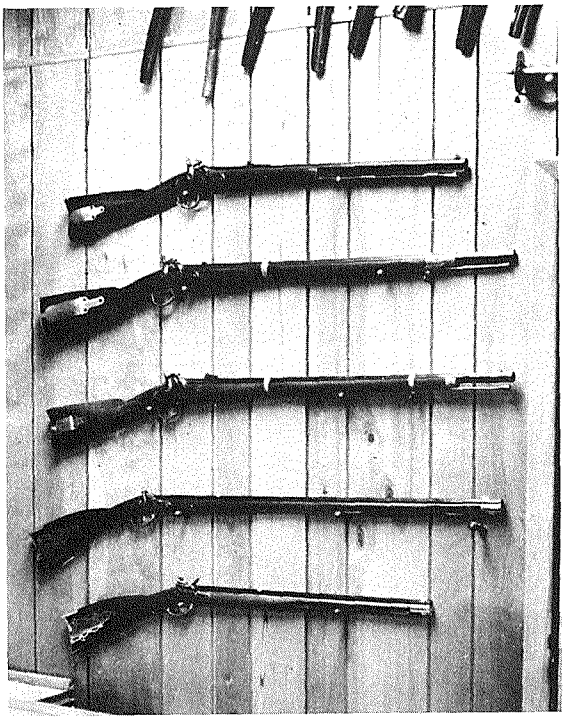
If a Minié ball is used, the procedure is simplified. After the charge is poured down the barrel, the Minié is pushed into the barrel by hand and seated with the ramrod. Add a cap and fire. After firing, leave the cap on the nipple to smother any sparks from the preceding shot. Whether you use a patched ball or a Minié, accuracy depends on perfecting your loading technique. Don't hurry, stick to a set routine, and you'll find that speed comes with practice.

Black powder shooting is not for the white-suited fastidious marksman, however. After a dozen or more shots, the shooter and his gun will be liberally covered with soot. While the soot scrubs off the shooter's skin easily, his gun is a lot harder to clean. Black powder soot is very hygroscopic—which means it tends to soak up moisture from the air. Within hours, depending on humidity, an uncleaned black powder gun can start to rust, so precautions must be taken as soon as a shooting session is over.

Several good black powder solvents are available to soften up the soot and speed cleaning, but to really clean a black-powder muzzleloader there is no substitute for hot water, soap and lots of elbow grease. Start by putting a piece of rubber over the nipple and letting the hammer down to hold it in place. This seals the barrel which can then be filled with really hot, soapy water. A plastic or aluminum funnel in the muzzle will help get the hot water into the barrel rather than on the shooter. Let the hot water soak for about 15 minutes to soften up the powder fouling.

Then dump the water and run soapy patches through the bore until they come out clean. Next fill the barrel with clean hot water to flush out the soap. After flushing several times with hot water, the barrel should be quite hot. Run patches through the hot barrel until they come out absolutely clean and dry.

BLACK POWDER ready-to-fire replicas are shown in the photo below. They are from top to bottom, an 1855 Buffalo Hunter; 1841 Mississippi Rifle; 1864 Remington Zouave Rifle; 1797 Kentucky Percussion; 1797 Kentucky Flintlock Carbine. They are all manufactured and available from the Navy Arms Co., Ridgefield, NJ.

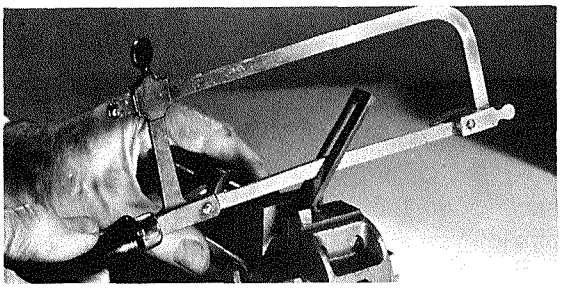


oil before reassembling

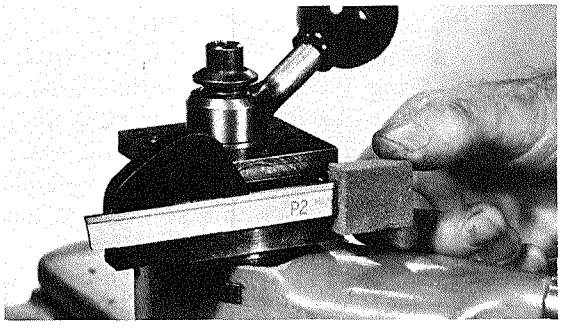
Next step is to clean the breech area with a damp cloth. A toothbrush is ideal to get into those crevices and crannies around the nipple and tang. If you intend not to shoot the gun for some time, remove the nipple and clean it thoroughly. While the gun is still warm from the hot water, apply oil to all metal parts and reassemble. Check your gun for the next few days to make sure you have removed all the fouling and no rust is commencing. The bore should be swabbed with a clean patch and reoiled. Your muzzleloader will last for generations if cleaned thoroughly after firing and kept well oiled and cared for as outlined here.

For a beginner thinking about getting started and the experienced shooter as well, Lyman's 26-page booklet, *Black Powder Basics,* is one of the best guides for accurate muzzleload-shooting sport. The booklet provides clear and simple how-to information on loading flint and caplock rifles, bullet casting, patched and Minié balls, accuracy tips, loads and cleaning. And with nearly 75 models of rifles, shotguns and pistols now produced for the sport, a muzzleloader can look forward to endless collecting and shooting fun.

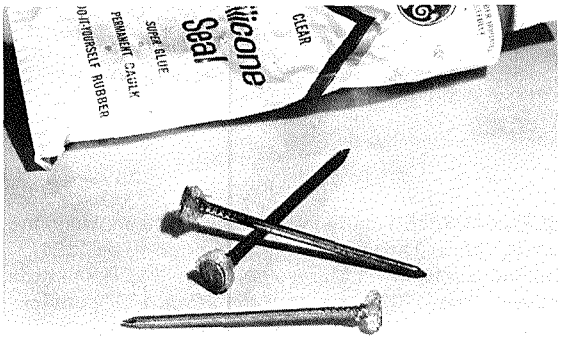
NARROW SLOTS are sometimes difficult to sand smooth, but there is one neat way to solve the problem. Cement some abrasive paper around a shop-fashioned "blade" made from a strip of tin-can metal. Then fasten your sanding blade in a jeweler's hacksaw.—*Walter E. Burton, Akron, OH.*



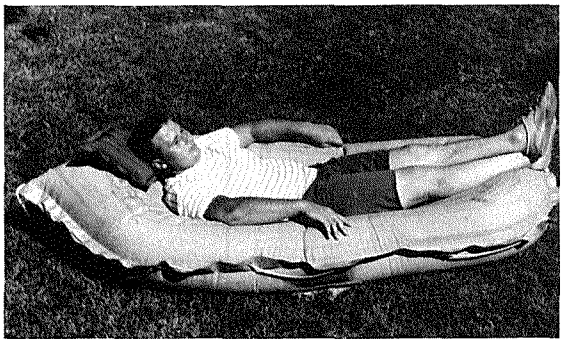
TO REDUCE THE CHANCE of nicked knuckles, try force-fitting a block of styrofoam over the tail end of a lathe cutoff tool bit. Simply form a slot that will let the block be pushed on easily, yet affords enough friction to hold it in place. If the foam shield tends to slip, secure it with a hefty rubber band.—*W.B. May, Oak Park, IL.*



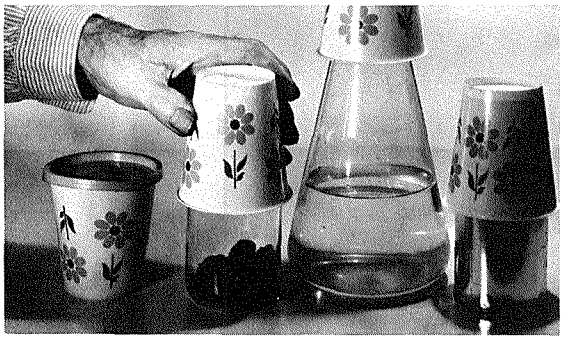
IF YOU ADD some padding under the heads, nails can be useful for holding materials such as plastics that might be damaged by conventional nailing. Here, silicone sealing compound has been applied in a ring around the nail's shank, just below the head. After the silicone has cured, the nails can be driven until the ring is compressed.—*Walter E. Burton, Akron, OH.*



NEXT TIME YOU are on a camping trip and all hammocks and cots are occupied by fellow campers taking an after-lunch siesta, turn to your rubber boat. Flopped upside down, it becomes a king-size air mattress, and will probably make the most comfortable "cot" in camp. It works so well you don't even need a pillow.—*John Krill, North Lima, OH.*



YOU CAN GIVE ecology a lift by "recycling" plastic containers—such as the type that cheese spreads come in—by using them as covers for laboratory flasks, glass jars or even tin cans. To use one, simply press it in place; its flexibility permits it to grip the rim of the container (provided that the rim is reasonably even).—*B.W. Erwin, Kent, OH.*



Drive the right nail

When you need a fastener, the chances are you'll think first of a nail; most of us do. But look over the available array before making your choice. Here they are

By W. CLYDE LAMMEY

NAILS MIGHT WELL BE CALLED universal fasteners. There are few common materials, other than rocks and some metals, you can't drive a nail into or all the way through one part and into another. There are even nails that can be driven into masonry.

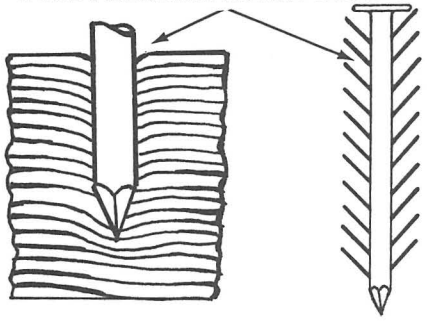
There's nothing new about nails as such. They are said to have been used by the Romans centuries ago. Our own colonials hand-forged them as late as 150 years ago. Of course, nails forged one by one at the fire were crude, but they did the job they were intended to do; and they are still doing it, as evidenced by the many 150-200-year-old homes still standing and essentially as sound and livable as ever.

Nowadays nails are of many types, sizes and shapes and are designed for specific purposes. That's why it's important to know which one to use where. Because of the many new building materials in sheet form that have been developed for builders and do-it-yourselfers, special nails have been made available. When you buy any of these materials for quick construction of a built-in, garage addition, an outbuilding for storage, or perhaps a patio roof, you'll need one of the special nails for the job. As an example, suppose you're roofing a patio with those colorful fiberglass panels. Obviously just any nail won't do. There's a nail specified for the purpose and no other should be used. It has a special head which keeps out water, sealing the hole tightly when it's driven home properly. And it's designed to hold, in any weather short of tornado-force winds.

If you've ever (and who hasn't) pulled a nail with a hammer you know the force it takes to withdraw even a small, skinny nail from wood. What makes it hold so tenaciously? Why does it refuse to let go until you've withdrawn it all the way to the point?

A look at the sketch on this page, left, tells why. As the nail is driven, the point breaks some of the tiny fibers in the wood and forces them downward. The point also wedges others apart as it is driven in. It is these severed and wedged fibers that offer such resistance to with-

WOOD FIBERS ACT AS TINY WEDGES

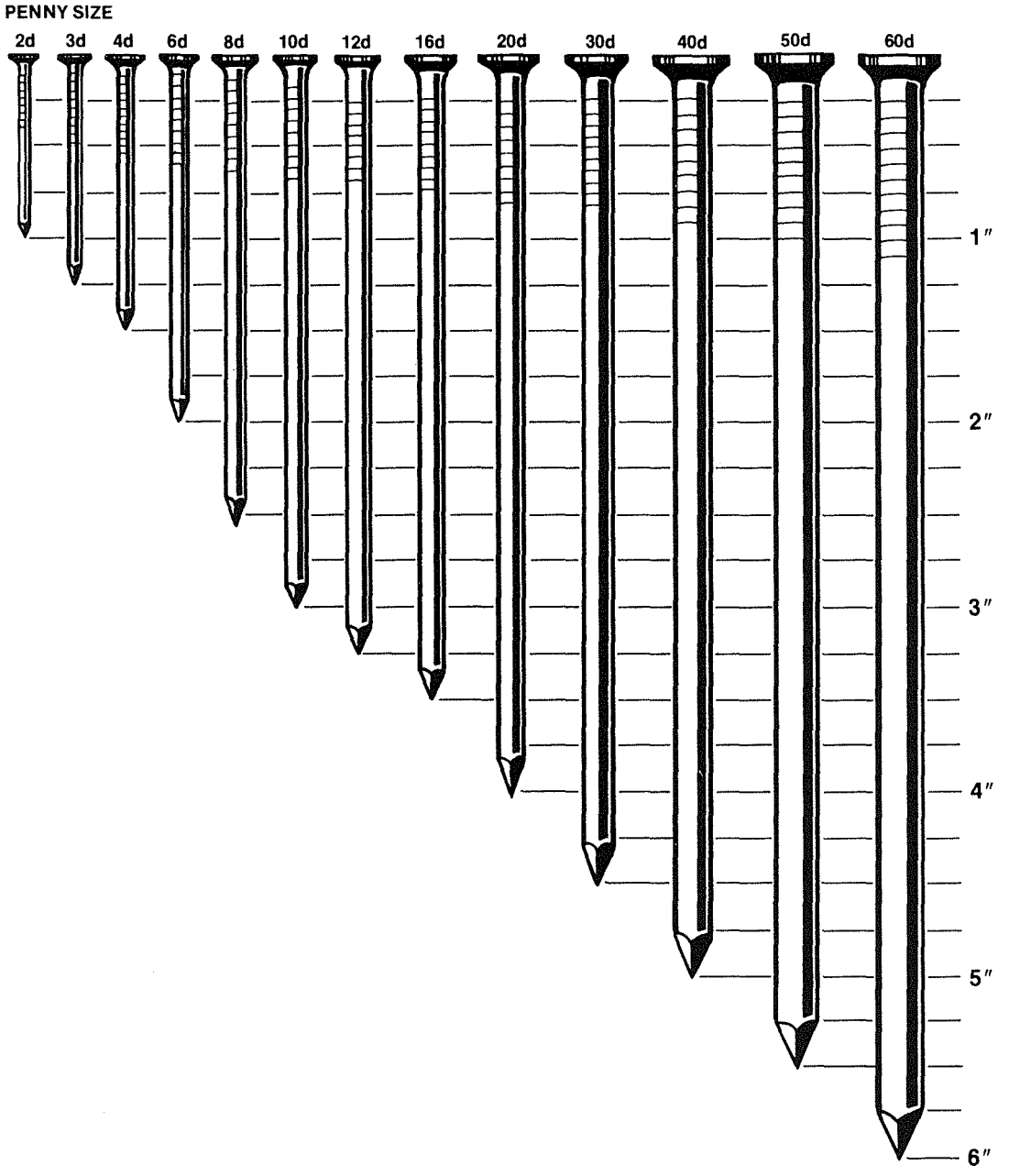


SEE ALSO

Bolts . . . Fasteners . . . Lumber . . . Measurements . . . Riveting . . . Roofs . . . Screws . . . Siding . . . Staple guns . . . Upholstery

NAIL SIZES

TYPE & PURPOSE	PENNY SIZE (d)	2	3	4	5	6	7	8	9	10	12	16	20	30	40	50	60
	LENGTH (in.)	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	4½	5	5½	6
COMMON NAILS:	GAUGE	15	14	12½	12½	11½	11½	10¼	10¼	9	9	8	6	5	4	3	2
For most rough work	HEAD DIA. (in.)	11/64	13/64	¼	¼	17/64	17/64	9/32	9/32	5/16	5/16	11/32	13/32	7/16	15/32	½	17/32
like framing	NO. PER LB.	847	543	294	254	167	150	101	92	66	61	47	29	22	17	13	10
BOX NAILS:	GAUGE		14½	14	14	12½	12½	11½		10½		10	9				
Smooth or barbed; for	HEAD DIA. (in.)		7/32	7/32	7/32	17/64	17/64	19/64		5/16		11/32	⅜				
boxes, crates, etc.	NO. PER LB.		588	453	389	225	200	136		90		69	50				
CASING NAILS:	GAUGE			14		12½		11½		10½		10					
For cabinet work,	HEAD DIA. (ga.)			11		9½		8½		7½		7					
interior trim, etc.	NO. PER LB.			489		244		147		96		73					
FINISHING NAILS:	GAUGE		15½	15		13		12½		11½							
For finer work than	HEAD DIA. (ga.)		12½	12		10		9½		8½							
casing nails	NO. PER LB.		880	630		288		196		124							

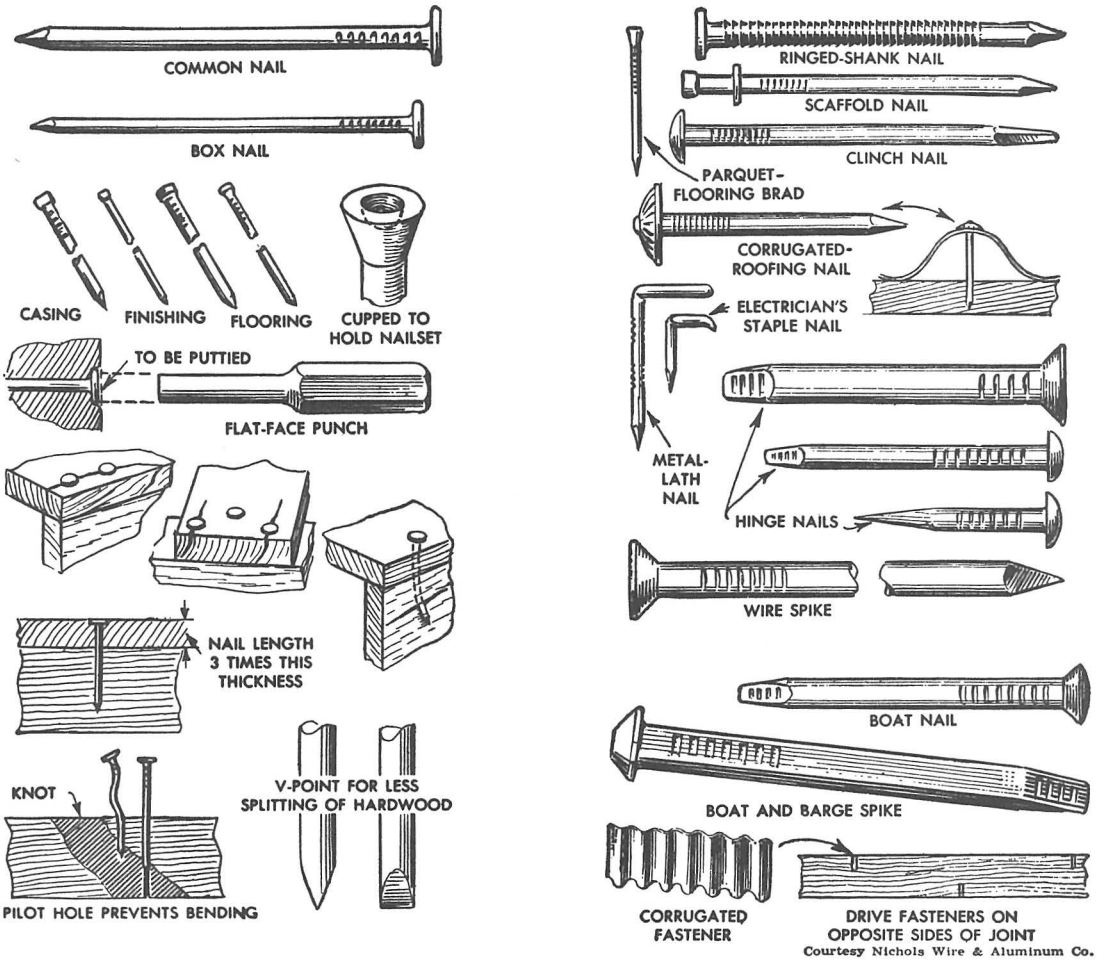


drawal of the nail. They grip the body of the nail tightly and they seldom relax their hold.

Nails are normally used to attach pieces one to another (if you use them as hooks or hangers, that doesn't count). The "attached piece" is, of course, the one to be held in place; the other is the holding piece, the one whose position is already firm. Carpenters and others who use nails as fasteners have a simple rule of thumb they like to follow when possible: About two-thirds of the nail's length should be in the holding piece.

Nails designated as "common" come in 6 to 20d sizes, "d" being the symbol for penny. The 20d is about the largest size that can be driven handily with an ordinary hammer.

The accompanying charts and details show most of the nails now commonly available. As new materials are developed there undoubtedly will be new nails and new nailing procedures in addition to those outlined. One example is the aluminum nail. These have been available in various sizes and forms for some time. At present they are most widely used for attaching siding and other parts exposed to weathering.



Courtesy Nichols Wire & Aluminum Co.

A
B

FLOORING BRADS
(A) 10 ga., 8d, plain or barbed. Head dia. 7 ga. 105 per lb.
(B) 11½ ga., 8d, plain or barbed. Head dia. 8 ga. 142 per lb. Easier driving in hardwood without splitting

WOOD-SIDING NAILS
Range from 5 to 10d and from 14 to 10½ ga.

ASPHALT-ROOFING NAILS
Galv., smooth or barbed. Lengths, ⅞, 1, 1¼, 1½, 1¾, and 2 in. Gauges, 12, 11 and 10. Head dia. from 9/32 to ½ in. Some checkered

STANDARD SHINGLE NAILS
From 1¼ to 1¾ in. in length. 14 to 12 ga. 271 to 434 per lb., depending on size. Use 1¾-in. for wood shingles laid over old shingles or roofing. Have regular or blunt diamond point

INSULATION SHEATHING
Galv. and barbed. Lengths, 1¾ and 2 in. 11 ga. 7/16-in. head. 155 and 136 per lb. Use 1¾-in. length for gypsum sheathing

INSULATION LATH
Blued, 1⅛ and 1¾-in. lengths, 13 ga., ⅜-in. heads. 499, 294 per lb. For gypsum lath use 1⅛-in. length

BARBED ASBESTOS-SHINGLE NAILS
Lengths 1¼, 1½, 1¾ and 2 in. 247, 210. 183 and 162 per lb. 11½ ga. 13/32-in. heads without fins

HARDBOARD AND BUILDING-BOARD NAILS
7 lengths from 1 to 1¾ in. by ⅛-in. steps. 17 ga., 3/32-in. head. Needle point. Bright galv. or cadmium plated. 885 to 1555 per lb., depending on size

GYPSUM WALLBOARD
Cement coated. Lengths, 1⅜, 1⅝, and 1⅞-in. 14, 13½ and 13 ga. 7/32, 15/64 and ¼-in. heads. 493, 366 and 278 per lb.

RED-CEDAR SHINGLES
3 or 4d for new roofs. 614 or 473 per lb. 5 or 6d for shingles over old roofs 404 or 276 per lb. Head dia. 7/32-in. 3 or 5d for 16 or 18-in. shingles, 4 or 6d for 24-in. shingles. Gauges 14½, 14, 14 or 13 for 3, 4, 5 and 6d sizes

SMALL WIRE BRADS:

Length (in.)	Gauges	Length (in.)	Gauges
3/16	20-24	⅝	13-22
¼	19-24	¾	13-21
⅜	18-24	⅞	13-20
½	14-23	1 & 1⅛	12-20

Larger sizes also available, including brad-head nails from 2 to 60d with same shank size as common nails

UPHOLSTERER'S TACKS

No.	Length (in.)	No.	Length (in.)
2	¼	10	⅝
2½	5/16	12	11/16
3	⅜	14	¾
4	7/16	16	13/16
6	½	18	⅞
8	9/16	22	1

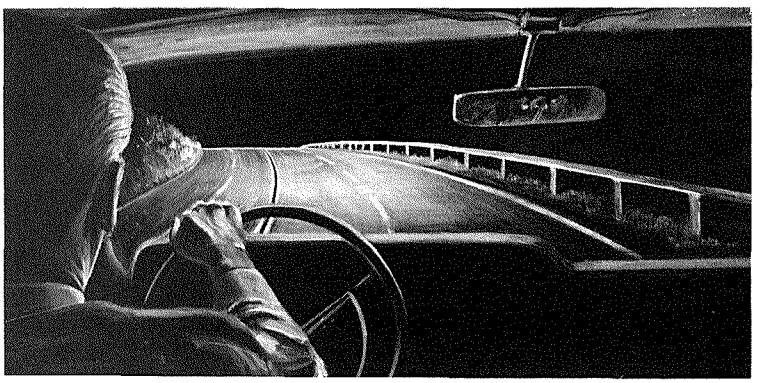
(Carpet tacks usually come Nos. 3, 4, 6, 8 and 10)

How to handle the hazards of night driving

By E. D. FALES JR.

Here are some hints from regular night-time drivers, state police and even a psychologist about how to keep yourself accident-free when trying to handle some of those long, lonely night trips

APPROACH CURVES on low beams to check for glow of on-coming car. Your high beams blot out the warning.



SEE ALSO

Autos, safety . . . Recreational vehicles . . . Trailers . . . Winter driving

DRIVING AT NIGHT is three times as dangerous as driving in daylight. Weird things can happen.

I know personally how easy it is on a rainy night to steer for a silver birch tree on a curve. After many hours on the road a single silver birch can look like an extension of a white center line. I darned near followed that "center line" into the woods one wet, weary night when the road veered sharply to the right.

watch for "phantoms"

The wee small hours bring out all sorts of phantoms, too. For example, a Wyoming driver worried for years about hitting stray horses. One night his headlights showed a herd racing across the road, tails flying, manes tossing. Scared stiff, he went into a long, screaming skid. When he finally stopped he found not a horse in sight; not a hoofprint. His tired mind had conjured up a phantom herd.

Then there was the Texas trucker who jackknifed one gloomy midnight. His partner, in another truck, stopped, ran forward, found his friend alive. "I hit a calf," the trucker said. But when they searched, there was no calf; there never had been. Another tired driver's phantom.

These two eerie cases are from the files of Dr. Alfred E. Moseley, Boston psychologist, who has investigated accidents for lawyers.

How can you avoid these traps?

First, says Dr. Moseley, by letting someone else drive when you are bothered, tired or angry. Next, by never driving more than ten minutes after your eyes get droopy. Finally, by being a 100 percent teetotaler, particularly when tired or upset.

What warning signs should you look for? Three, says Moseley: "First: applying the brakes suddenly without good reason. Second: misinterpreting night shadows and seeing things that aren't there. Third: 'homing in on'—aiming for—the wrong lights or turns." If *any* of these happen, you're heading for trouble and had better knock off for awhile.

- *Other night problems.* I can add these pointers of my own, based on years of on-the-road investigation:
- *Quit getting sore* when you think someone is

deliberately shining his high beams in your eyes. Usually he isn't. More on this later.

• *Know your own worst enemy* on the night road—the fellow police call the "wrong-way flyer." This is the mixed-up driver—usually stone drunk—who comes roaring toward you in your lane.

Warns the California Division of Highways: Look for him around bar-closing time. He's the fellow mainly responsible for those early-morning head-ons. California alone figures it had 33,000 "wrong way" incidents in a recent year.

avoiding "wrong way" flyer

If you see a wrong-way flyer coming on a two-way road, your best bet may be to pull off the road—far off. If you can't, it may be best to *stop* at once. However, conditions vary. Twice I met drunks coming fast on my side and I escaped only by steering left and passing them on my right. But this is highly dangerous. It makes *you* a wrong-way guy, and if the other fellow switches back to his lane a smart lawyer could make you appear to be at fault.

• *Use low beams on sharp curves.* Most drivers go into blind curves on high beams, then get startled when someone comes around the curve without warning. It's a mistake to approach blind curves on high beam, since your brights blot out the advance warning glow of cars coming toward you.

• *But also use a warning "flick."* Going into a blind curve, it pays to flick to brights once or twice, just for a second. This changes the intensity of light at the apex of the curve, helps the other fellow know you're coming.

• *Look for "deer lights."* One of the worst (but least-known) night dangers is deer. Deer roam most states and many motorists have hit, or at least had a close brush with them. I have hit one, even had one jump over the hood as I turned into a farm road. Keep a sharp watch, especially toward dawn (when deer come down to feed in roadside ditches) for deer eyes. A deer's eye is as reflective as a cat's: It looks like a pocket flashlight, or the shiny end of a beer can, hung in bushes or small trees. When you see it, brake fast. Remember, a deer won't turn like a cat and run back into the woods; he usually jumps into the road.

overdriving your lights

• *Suppose you have to overdrive your lights?* It's absurd but true that most of our wonderful new roads are designed so you can't use your high-beam lights. If you do, you throw an unbearable glare at other drivers. Experts say: "Use low beams on high-speed roads, but don't overdrive them." Taken seriously, this would slow night traffic on all super-roads to 40 mph or less—for many low beams shine no more than 100 feet ahead.

DEER ROAM roads at night, especially toward dawn. A deer's eyes are highly reflective, often resemble reflection of a beer can on the roadside.

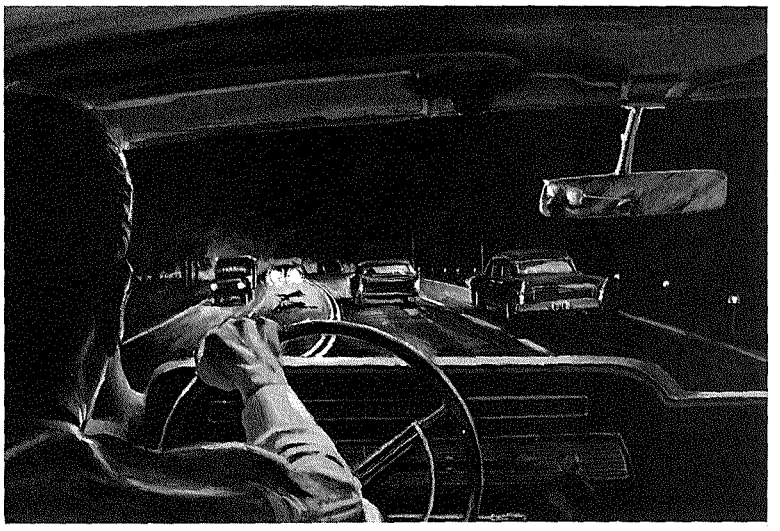
So what *can* you do?

• *Reflection driving.* You must learn a whole new technique of driving by reflection. Quit relying on your own lights (which are really quite feeble, even on high beam) and learn to see by other means. For example:

1. *Steer by other driver's lights.* Cars ahead of you cast a good deal of *side* glow. Let this "sweep" the road for you.

2. *Read the reflector-posts.* These form a corridor of light against which a stalled car or truck shows up black.

CLUES to night-driving vision include other drivers' lights, "reading" roadside reflectors, white lines.



3. *Read the road-striping* (edge-stripe and lane-stripes) as far ahead as possible. Debris, dogs, even pedestrians show up as a black break in the stripe.

4. *Read the reflection of oncoming lights in the road.* And watch for the night mirage effect—"puddles" of reflected headlights. Eyeing these closely tells you much about the road beyond your headlights.

how to read reflections

Many drivers don't let reflections work for them. The side sweep of approaching headlights is not bright, but it can tell you a great deal about what is ahead in your lane if you'll *read* it carefully in the last quarter-mile before a pass. Even taillight reflections show lane stripes and bumps before your own lights pick them up. Today's bright red lights actually help illuminate many high-speed roads.

• *If your headlights ever go out,* you'll never forget the experience. On a deserted road far from lights it's terrifying. On a busy road, other car lights will help you and your big problem will be to get to the shoulder fast before you're hit. Here's what you can do to survive:

1. *Get your left turn signal on—quick!* If there's a center line, most turn flashers will pick it up and guide you to a stop. Practice this trick mentally and often, or when the time comes you'll be so shocked it may take precious seconds to remember.

2. *If no center line,* hunt for the edge with your right-turn flasher.

3. *If all your lights go out* (as when a battery cable parts), steer by the lights of other cars—if any.

4. *In dire emergency* (only) put a passenger out with a flashlight to walk the shoulder and lead you.

5. *On deserted roads* in critical emergency remember that you *can* also run backward using your backup lights. Never try this when other traffic is moving. It's very hazardous because those feeble lights can look like two beer cans to drivers coming from behind.

In general, should your lights go out, proceed cautiously if they suddenly come on again. A loose wire may have made contact. In any event, the lights may go off again in seconds. Prepare for it.

Never assume other drivers can see you. At 30 mph they may; but at 60 they'll hit an unlighted car before they'll see it. *Best bet:* Pull far off the road and wait for help.

• *What about the fellow who won't dim* or, worse, throws his brights into your eyes just before he meets you? Most of us get sore and fight back with our own brights. And we wonder: "Why did he do it? How could any driver be that dirty?"

The answer, I have learned in roadside interviews, is: The "won't dim" driver usually doesn't even know he offended you! He didn't mean it. And sometimes he thought he was dropping his beams instead of raising them. Another cause: headlights out of adjustment. If he can't dim, blinding him with your highs won't make him less of a hazard to you.

drunk won't even notice you

Maryland police have found that when a driver won't dim for you, he may be drunk. He doesn't notice you at all.

I have also found that he is sometimes cold sober but dog-tired. After many hours on the road, a tired driver acts a little like a drunk. He's dazed.

Some drivers who suddenly blind you actually haven't touched the foot switch at all. Here's what happens. Say you come up one side of a hill, some other fellow comes up the other side. He's using brights. As he gets to the top he politely kicks the beams down for you—pouring his low beams straight into your eyes because he's above you. If he's on a right curve (a *left* curve, to you) you get it all the worse.

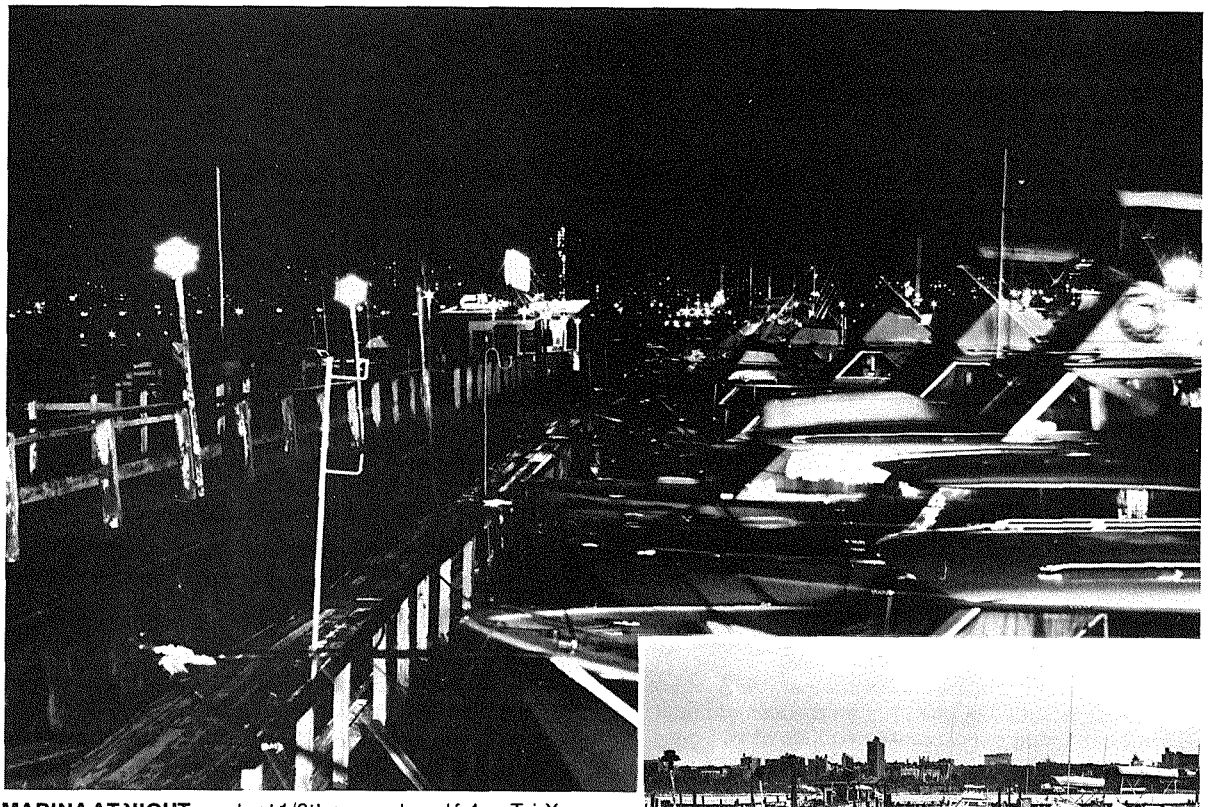
Remember this at hilltops. Sometimes it pays to keep your beams up a few seconds longer so they will sweep the sky *over* his car as he ascends the slope.

• *What to do when tired.* We've all been given lots of advice: open the windows, turn on the radio, stretch, shout, drink coffee. Forget it. If a sudden need for sleep overwhelms you, there's only one thing to do—*sleep!* Stop in a safe place. A 30-minute nap works wonders.

The other antisleep tricks, Dr. Moseley says, actually increase your danger. They may work for five minutes. But then sleep moves in again—with no warning, no nodding head, no sudden presleep quiver.

stop and take a nap

Never fight sleep, Moseley says. It fights back and tricks you. Stop and let sleep take over. On a long vacation trip you may need *two* short naps, a half hour apart. After that you should feel great. Two naps often seem as good as a night's sleep.



MARINA AT NIGHT, made at 1/8th second, and f:4 on Tri-X, is much more dramatic than the same scene in daylight. The slight blur is caused by boats bobbing in the water during exposure, but it isn't objectionable.

How to shoot in the dark

By JIM SLATER

Double your photography pleasure by trying for the spectacular shots waiting for you at night wherever you look

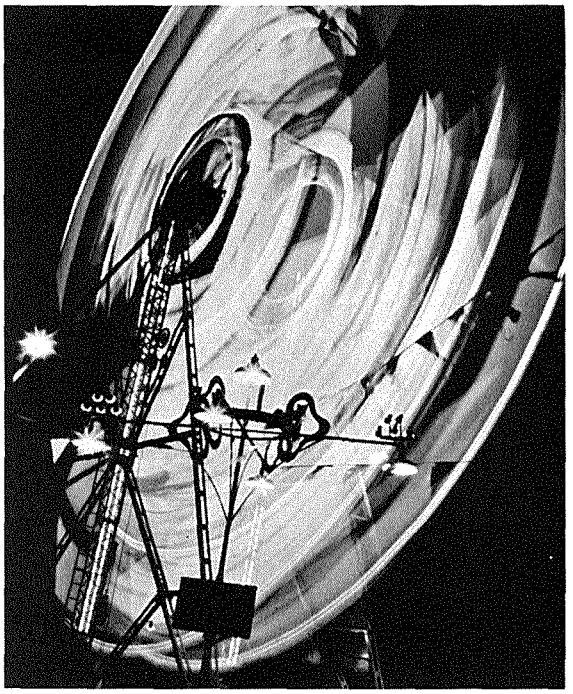
■ TO INTRODUCE a new kind of excitement into your photography, become a night person. Put aside your flash gun, because flash is a substitute for the sun and turns night into day. Instead, take pictures of the night as it really is—moonlit scenes, flashing billboards, streets that sparkle with neon stars, amusement parks with whirling, twisting lights, marinas or sandy beaches touched by light—a different world of picture possibilities.

You learn one thing quickly when you get into night photography. In daylight, you shoot pictures of lighted objects, and you are concerned about the way the light falls on your subject. At night, however, you photograph *the lights themselves*. Keep this in mind as you begin your night photography adventure and you are off to a good start.

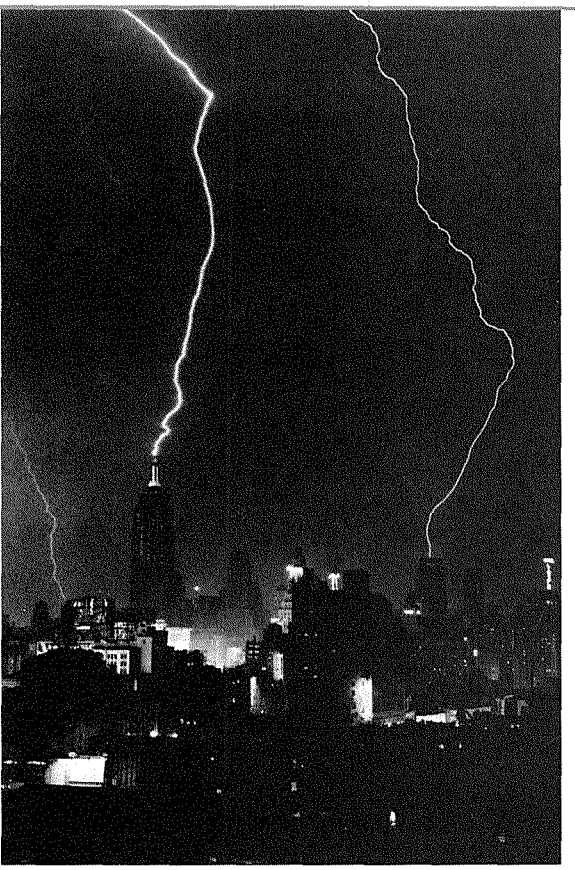
Generally at night you shoot for the light that is available. To get this light, you use fast films which are extremely sensitive to light. Put away your light meter because it can't tell you much about these low-light situations. Instead, you experiment with different exposures at widely different times. You learn to shoot sequences of

SEE ALSO

Exposure meters . . . Lenses, photo . . . Montages, photo . . . Outdoor photography . . . Panorama photos . . . Photo hints . . . Photography . . . Telephotos . . . Underwater photos



WHIRLING WHEEL OF LIGHT is an amusement-park ride shot at a long exposure—8 seconds at f:11 on Ektachrome 200. Striking effects like this photo, shot by Eastman, can't be made in daytime.



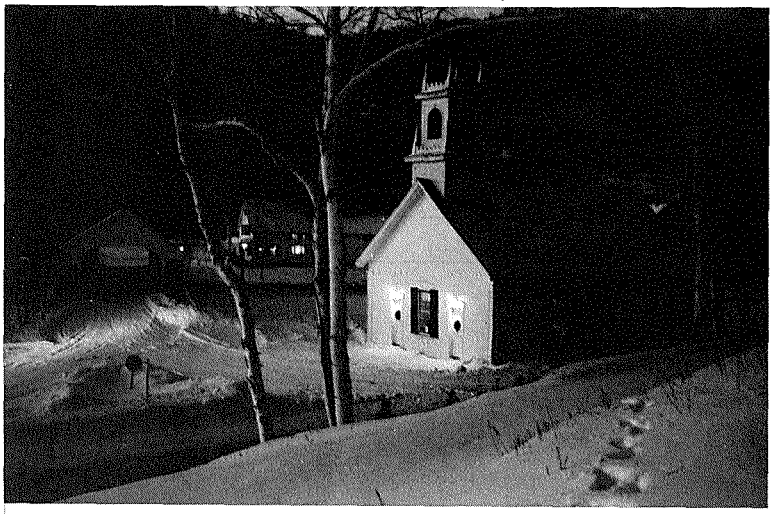
LIGHTNING IS EASIER to shoot than you'd think because it provides light to take its own picture. Use the bulb setting to open the shutter, hold it open until the lightning flashes, then close it.

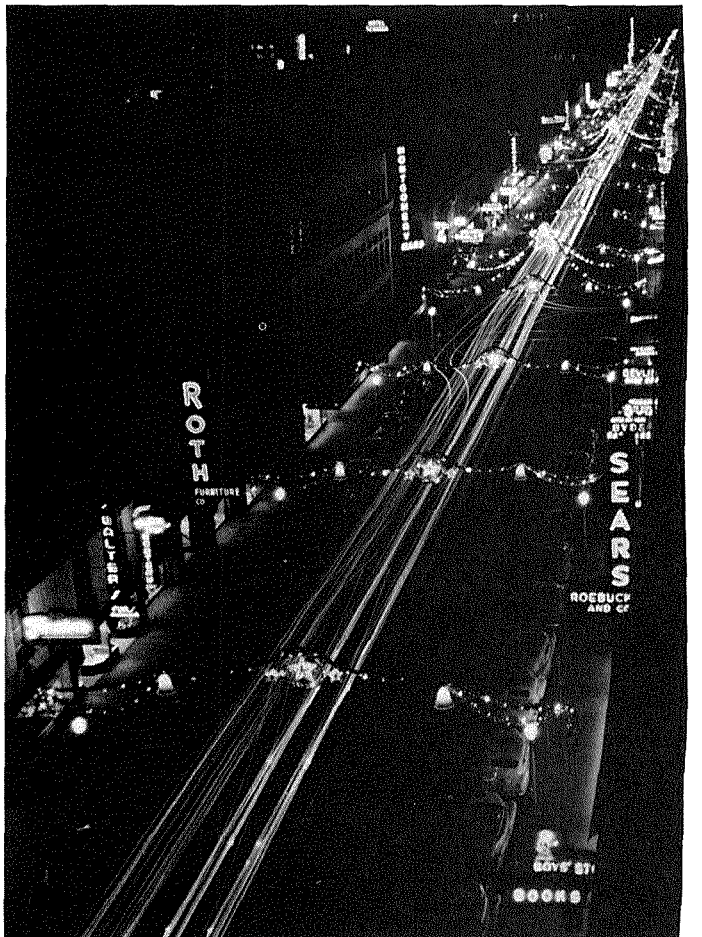
perhaps half a dozen different shots of the same picture. You learn to bracket every exposure; and you learn to use long, long exposures. And finally, you learn to use a tripod and a cable release for most of your shots.

First, the film: For black-and-white night photography, there is the old reliable Eastman Tri-X, with an ASA rating of 400. It has the speed and the latitude for any kind of a night situation.

RIBBONS OF LIGHT are traced by automobile headlights blurred through a time exposure of several seconds. Always use a tripod or other firm support to keep the camera steady during such exposures.

COUNTRY CHURCH in the snow makes a picturesque night scene. To get enough illumination, this was shot at dusk—a trick you can use when full darkness would make shooting this scene impossible.





Or if you want, there are faster films available, up to as high as 1600 ASA. These, however, tend to be pretty grainy.

Color shots once were restricted to bright sunny days. Then came such films as Eastman's Highspeed Ektachrome, now rated at 200 ASA (and which can be push-processed to 400 ASA), and color entered the field of night photography. Now both Eastman and Fuji have films for making color prints rated at 400 ASA—which means you can take on any challenge the night has to offer and get spectacular pictures.

Techniques: Most of your exposures will be long, which means that you should always support your camera on a tripod. It is almost impossible to get good, sharp pictures when hand-holding a camera set at speeds slower than 1/60 of a second. It also is wise to use a cable release instead of pressing the shutter release, again to eliminate any source of vibration which might blur the photo.

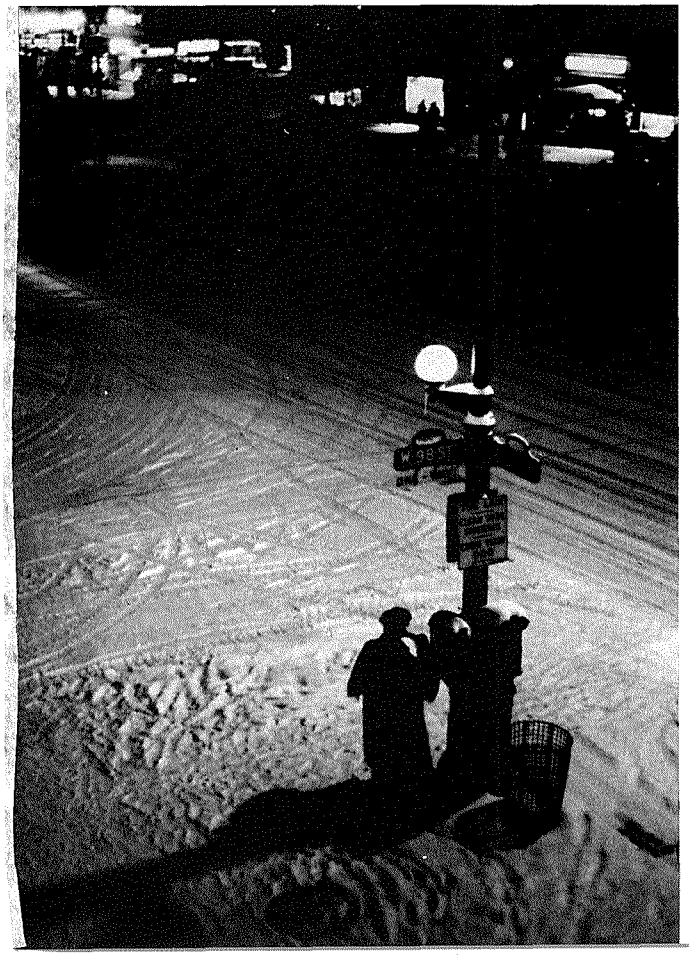
All cameras have time-exposure capabilities and also "bulb" settings, which you use to hold the shutter open as long as you need it. If yours is one of the newer electronic cameras, you may have automatic timing of time exposures up to 8 or even 10 minutes, a great help for night work. Check your camera manual for details.

Bracketing and sequencing of exposures are the most important techniques in night photography. To bracket in daylight photography, you shoot one picture at the setting indicated on your light meter, then shoot a second at the next lower f-stop, and a third at the next higher f-stop. This is a good way to be sure of getting one perfect exposure.

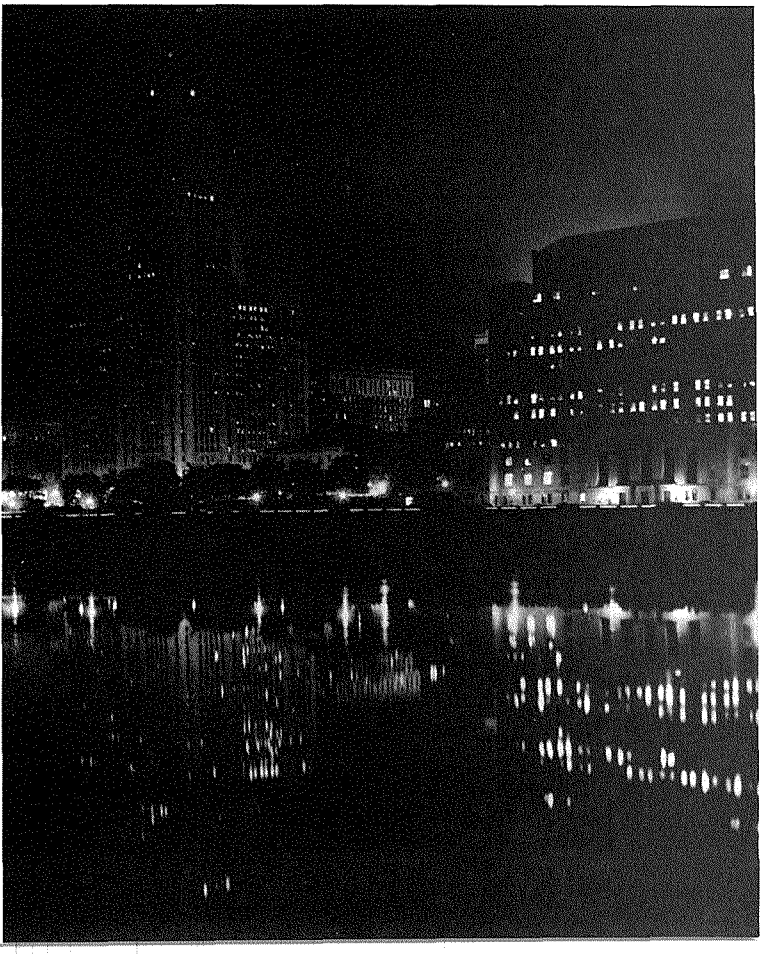
Night bracketing is a little different. You want as much depth of field in your picture as possible, so you try to shoot at the smallest possible aperture. The pictures on these pages were shot at f:4, but might have been taken at f:8, or f:11 for greater depth. The smaller the f-stop, of course, the longer the exposure, and you should plan to get the best balance between time and aperture opening.

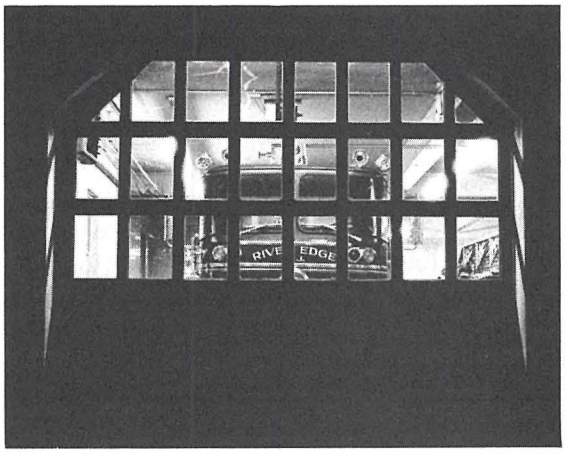
When bracketing at night, you change the *time* and not the f-stop. Thus you might shoot your first shot at f:8 at an exposure of 2 minutes. Then, to bracket, you would change the time, and shoot the second shot at 4 minutes and the

LONELY VIGIL of a policeman on a deserted, snowy street corner is captured in this photo shot from the window of a nearby building. Such shots create strong moods and attractive salon prints.



REFLECTIONS ON WATER, here from buildings along a river, are spectacular at night because of the shimmering lights. Wet lamplighted streets after a rain also produce eye-catching night effects.





LIGHTED FIREHOUSE is a good example of a subject that takes on new interest at night. In this case, the flash was fired during a time exposure to give a slight added illumination. The close-up of the firehouse door at the right creates an interesting light pattern.

third at 1 minute. Note that you shoot successive shots at double or half the previous shot. Thus, if you shoot one at 3 minutes, then the second would be at 6 minutes, and the third at 1½ minutes.

Sequencing of exposures is simply the shooting of the same scene at a series of settings. You might do shots at 1, 2, 4 and 8 minutes, and also at 1/250, 1/125, 1/60, 1/30, etc. The result of shooting such a sequence may surprise you. First, you'll note that you end up with a number of excellent photos. In the long exposures, you will find that an additional 4 seconds may have made very little difference.

The pictures you get will be different in subtle ways, and each will have its own mood. The longer exposures will have more over-all illumination, and light sources will be burned in and appear as diffused hot spots. On the shorter exposures, the light sources will be sharper and better defined. It is possible to get two or three prize winners in one such sequence.

Special effects: Look for opportunities to achieve special lighting effects in your night shots. For example, shoot on rainy nights and take advantage of the reflection of existing lights in the wet street surfaces. Or shoot with a river, lake, or pond in the foreground for reflections on water. Night lights on snow provide another beautiful effect. Also, shoot the same scene on a dry night, a wet night, and a snowy night. You'll have a lovely set of photos to mount side by side.

You can use your flash at night to fill in some scenes. The firehouse shot shown here was made with flash fill. To make this shot, the shutter was set at f:4 and then opened. While it was open, the flash was fired manually. Then the shutter was closed. Don't use the camera's built-in flash synchronization for a shot like this, because you don't want a flash picture.

Fireworks can provide an interesting night shot. One way to do it is to set the camera on the tripod so that it is pointed at the area of the sky where the fireworks will explode. Lock the shutter open and cover the opening with your hand or a card. When the burst lights the sky, pull the card away. Cover the lens again when the burst has died down. You can do this four or five times to make one picture of bursting fireworks.

Shots which take advantage of the fact that long exposures cause moving lights to blur into streaks are always interesting. Set your camera on a bridge over a freeway, for example, or shoot from the window of a building which looks into a lighted downtown street. The lights of the moving cars will appear as solid streaks in your picture.

TYPICAL EXPOSURE TIMES FOR NIGHT SCENES

(All times are for an opening of f/4. Adjust one stop shorter or longer for each stop of increase or decrease in opening.)

TYPE OF FILM	TYPE OF SCENE		
	NEON SIGNS	STREET SCENES	FLOOD-LIGHTED BUILDINGS
EKTACHROME 64 KODACHROME 64	1/30	1/15	2 sec
KODACOLOR II	1/30	1/30	1 sec
EKTACHROME 200	1/60	1/30	1 sec
KODACOLOR 400 TRI-X 400	1/250	1/125	1/4

METRIC CONVERSION

Conversion factors can be carried so far they become impractical. In cases below where an entry is exact it is followed by an asterisk (*). Where considerable rounding off has taken place, the entry is followed by a + or a - sign.

CUSTOMARY TO METRIC

Linear Measure

inches	millimeters
1/16	1.5875*
1/8	3.2
3/16	4.8
1/4	6.35*
5/16	7.9
3/8	9.5
7/16	11.1
1/2	12.7*
9/16	14.3
5/8	15.9
11/16	17.5
3/4	19.05*
13/16	20.6
7/8	22.2
15/16	23.8
1	25.4*

inches	centimeters
1	2.54*
2	5.1
3	7.6
4	10.2
5	12.7*
6	15.2
7	17.8
8	20.3
9	22.9
10	25.4*
11	27.9
12	30.5

feet	centimeters	meters
1	30.48*	.3048*
2	61	.61
3	91	.91
4	122	1.22
5	152	1.52
6	183	1.83
7	213	2.13
8	244	2.44
9	274	2.74
10	305	3.05
50	1524*	15.24*
100	3048*	30.48*

1 yard = .9144* meters
1 rod = 5.0292* meters
1 mile = 1.6 kilometers
1 nautical mile = 1.852* kilometers

Fluid Measure

(Milliliters [ml] and cubic centimeters [cc or cu cm] are equivalent, but it is customary to use milliliters for liquids.)

1 cu in = 16.39 ml
1 fl oz = 29.6 ml
1 cup = 237 ml
1 pint = 473 ml
1 quart = 946 ml
= .946 liters
1 gallon = 3785 ml
= 3.785 liters
Formula (exact):
fluid ounces × 29.573 529 562 5* = milliliters

Weights

ounces	grams
1	28.3
2	56.7
3	85
4	113
5	142
6	170
7	198
8	227
9	255
10	283
11	312
12	340
13	369
14	397
15	425
16	454

Formula (exact):
ounces × 28.349 523 125* = grams

pounds	kilograms
1	.45
2	.9
3	1.4
4	1.8
5	2.3
6	2.7
7	3.2
8	3.6
9	4.1
10	4.5

1 short ton (2000 lbs) = 907 kilograms (kg)
Formula (exact):
pounds × .453 592 37* = kilograms

Volume

1 cu in = 16.39 cubic centimeters (cc)
1 cu ft = 28 316.7 cc
1 bushel = 35 239.1 cc
1 peck = 8 809.8 cc

Area

1 sq in = 6.45 sq cm
1 sq ft = 929 sq cm
= .093 sq meters
1 sq yd = .84 sq meters
1 acre = 4 046.9 sq meters
= .404 7 hectares
1 sq mile = 2 589 988 sq meters
= 259 hectares
= 2.589 9 sq kilometers

Kitchen Measure

1 teaspoon = 4.93 milliliters (ml)
1 Tablespoon = 14.79 milliliters (ml)

Miscellaneous

1 British thermal unit (Btu) (mean) = 1 055.9 joules
1 calorie (mean) = 4.19 joules
1 horsepower = 745.7 watts
= .75 kilowatts
caliber (diameter of a firearm's bore in hundredths of an inch) = .254 millimeters (mm)
1 atmosphere pressure = 101 325* pascals (newtons per sq meter)
1 pound per square inch (psi) = 6 895 pascals
1 pound per square foot = 47.9 pascals
1 knot = 1.85 kilometers per hour
25 miles per hour = 40.2 kilometers per hour
50 miles per hour = 80.5 kilometers per hour
75 miles per hour = 120.7 kilometers per hour

METRIC TO CUSTOMARY

Linear Measure

millimeters (mm)	fractions of an inch (to nearest 1/64")
1	3/64 -
2	5/64 +
3	7/64 -
4	11/64 -
5	13/64 -
6	15/64 +
7	17/64 +
8	5/16 +
9	23/64 -
10	25/64 +

Formula:
millimeters × .039 37 = inches

centimeters (cm)	inches (to nearest 1/64")
1	25/64 +
2	25/32 +
3	1 3/16 -
4	1 37/64 -
5	1 37/32 -
6	2 23/64 +
7	2 3/4 +
8	3 5/32 -
9	3 35/64 -
10	3 15/16 -

Formula:
centimeters × .393 7 = inches

meters	feet (to nearest 1/4 inch)
1	3' 3 1/4 + "
2	6' 6 3/4 - "
3	9' 10 + "
4	13' 1 1/2 + "
5	16' 4 3/4 + "
6	19' 8 1/4 - "
7	22' 11 1/2 + "
8	26' 3 - "
9	29' 6 1/4 + "
10	32' 9 1/2 + "

Formula:
meters × 3.280 8 = feet
1 kilometer = 3280.839 8 feet
= .621 371 miles

Fluid Measure

1 milliliter (ml)	= .034- oz (fluid ounces)
10 ml	= .34- oz
100 ml	= 3.4- oz
1 liter	= 33.8 + oz
	= 2 pints, 2- oz
	= 1 quart, 2- oz

Formulas:
liters × 33.814 056 = ounces (fluid)
milliliters × .033 814 056 = ounces (fluid)

Weight

grams	ounces (avoirdupois)
1	.035 +
10	.353 -
50	1.76 +
100	3.52 -
500	1 lb 1.7 - oz
1000	2 lb 3.3 - oz

Formula:
grams × .035 273 99 = ounces (avoirdupois)

kilograms	pounds (to the nearest ounce)
1	2 lb 3 + oz
2	4 lb 7 - oz
3	6 lb 9 + oz
4	8 lb 13 + oz
5	11 + lb
6	13 lb 4 - oz
7	15 lb 7 - oz
8	17 lb 10 + oz
9	19 lb 13 - oz
10	22 lb 1 - oz

Formula:
kilograms × 2.204 622 4 = pounds
1 metric ton (1000 kg) = 2 204.6 pounds

Volume

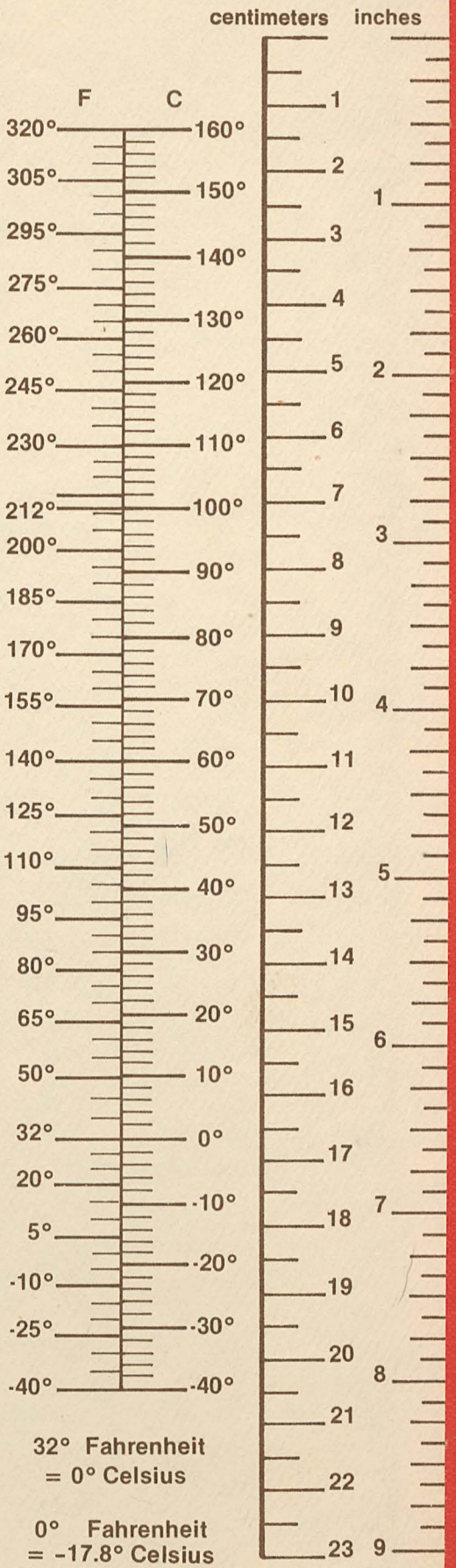
1 cubic centimeter (= 1 milliliter) = .061 + cubic inches
1 liter (1000 cc) = 61 + cubic inches
1 cubic meter = 35.3 + cubic feet

Area

1 square centimeter = .155 square inches
1 square decimeter = 15.5 square inches
1 square meter = 9.29 square feet = .84- square yards
1 hectare (10 000 sq. meters) = 2.47 + acres

Miscellaneous

1 newton (N) = 4.45- pounds of force
1 pascal (Pa) (pressure) = .000 145 + psi
= .021- pounds per sq ft
1 kilopascal (kPa) = .145 + psi
= 21- pounds per sq ft
25 kilometers per hour (km/h) = 15.5 + mph
50 km/h = 31.1- mph
75 km/h = 46.6 + mph
100 km/h = 62.1 + mph
Formula:
km/h × .621 371 = miles per hour



32° Fahrenheit = 0° Celsius

0° Fahrenheit = -17.8° Celsius